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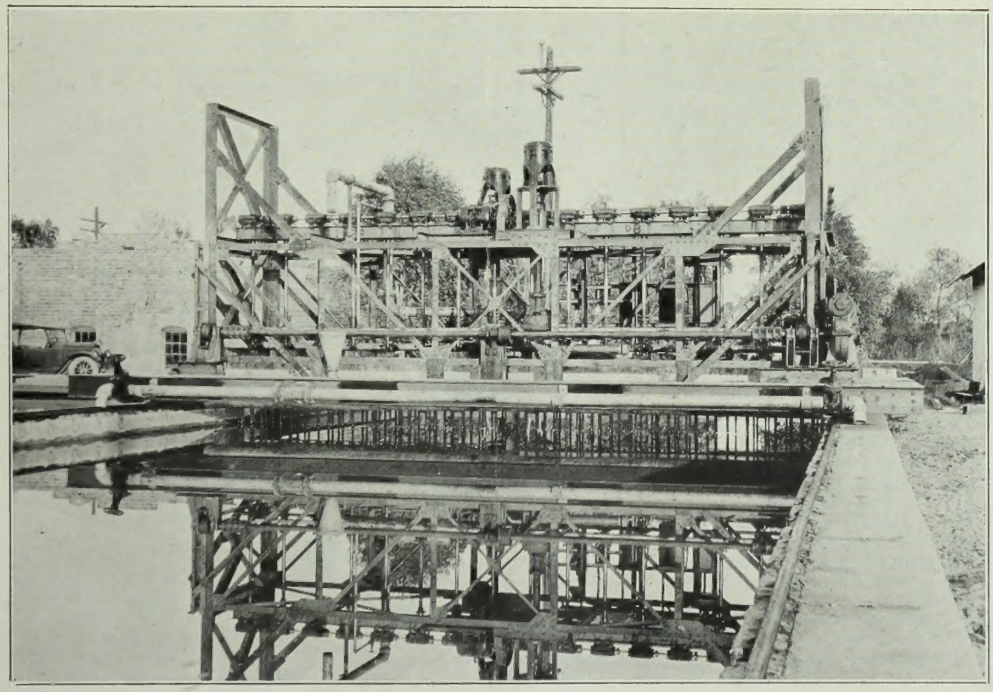
MODERN Irrigation

The Magazine of Applied Hydraulics

Hydraulic engineering

Vol. III JANUARY, 1927 No. 1



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First Publication of the Minority Report on the San Gabriel River Dam Sites

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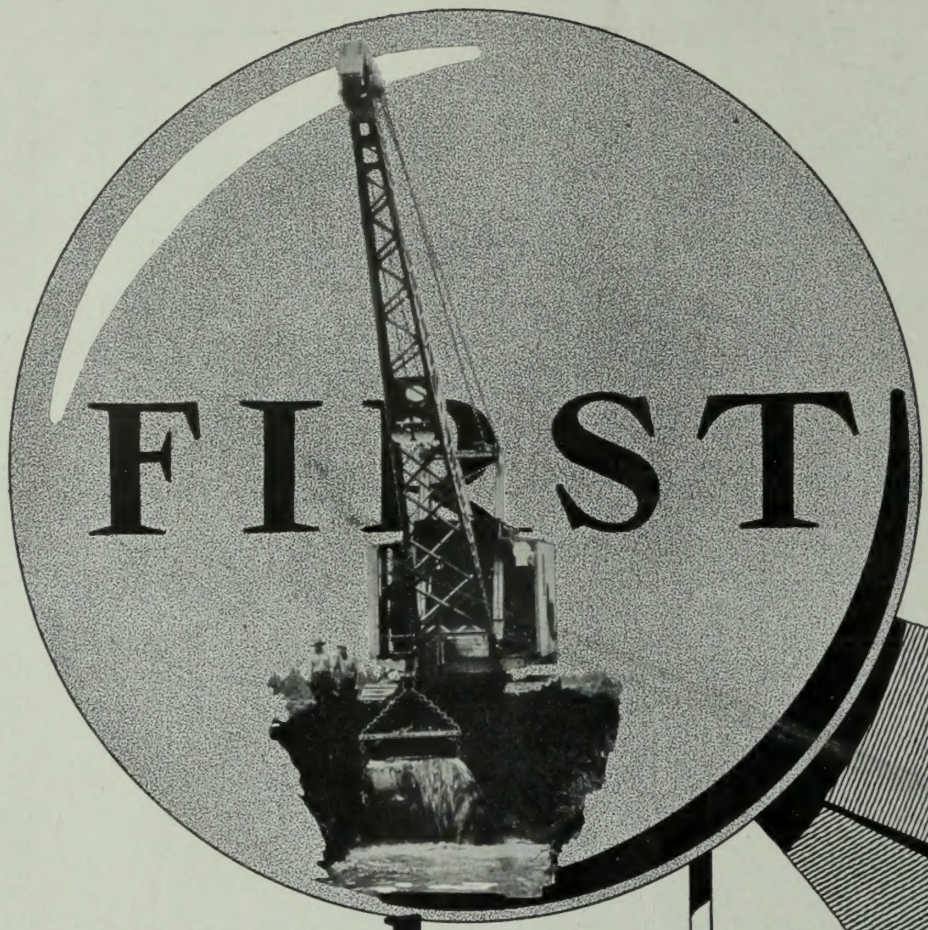

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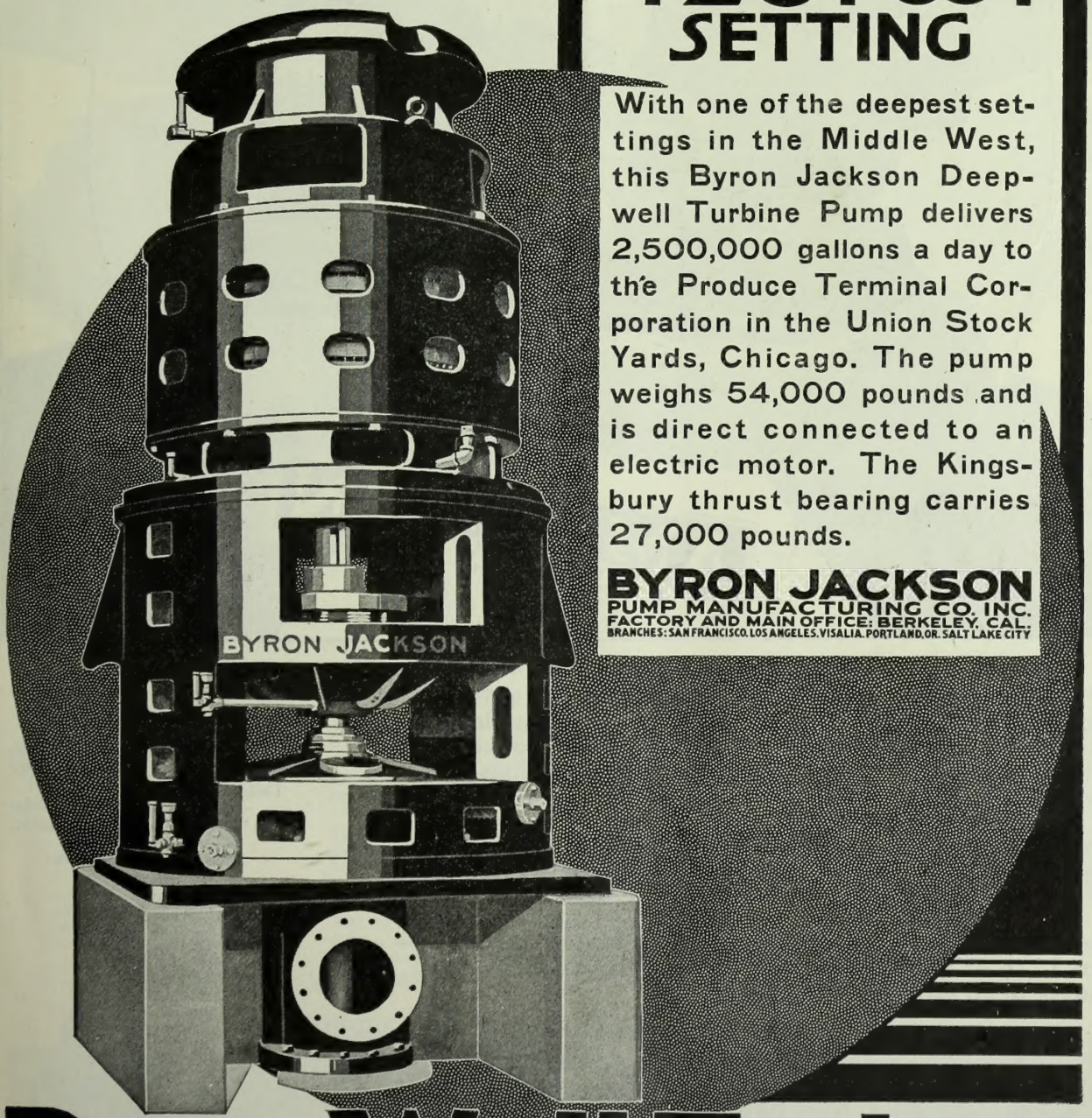

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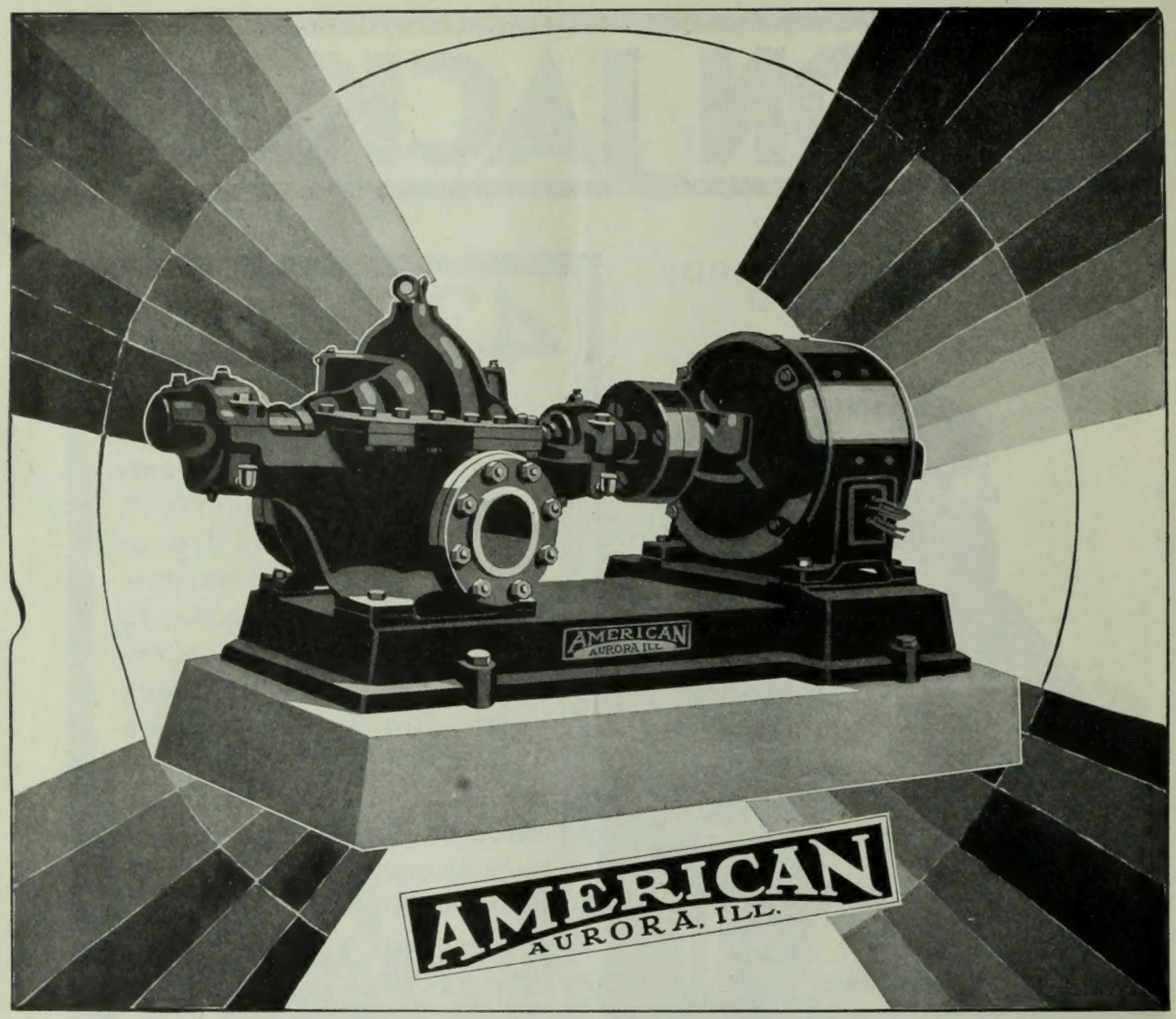

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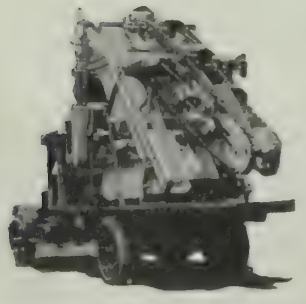

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"Western Waterworks" Begins on Page 25

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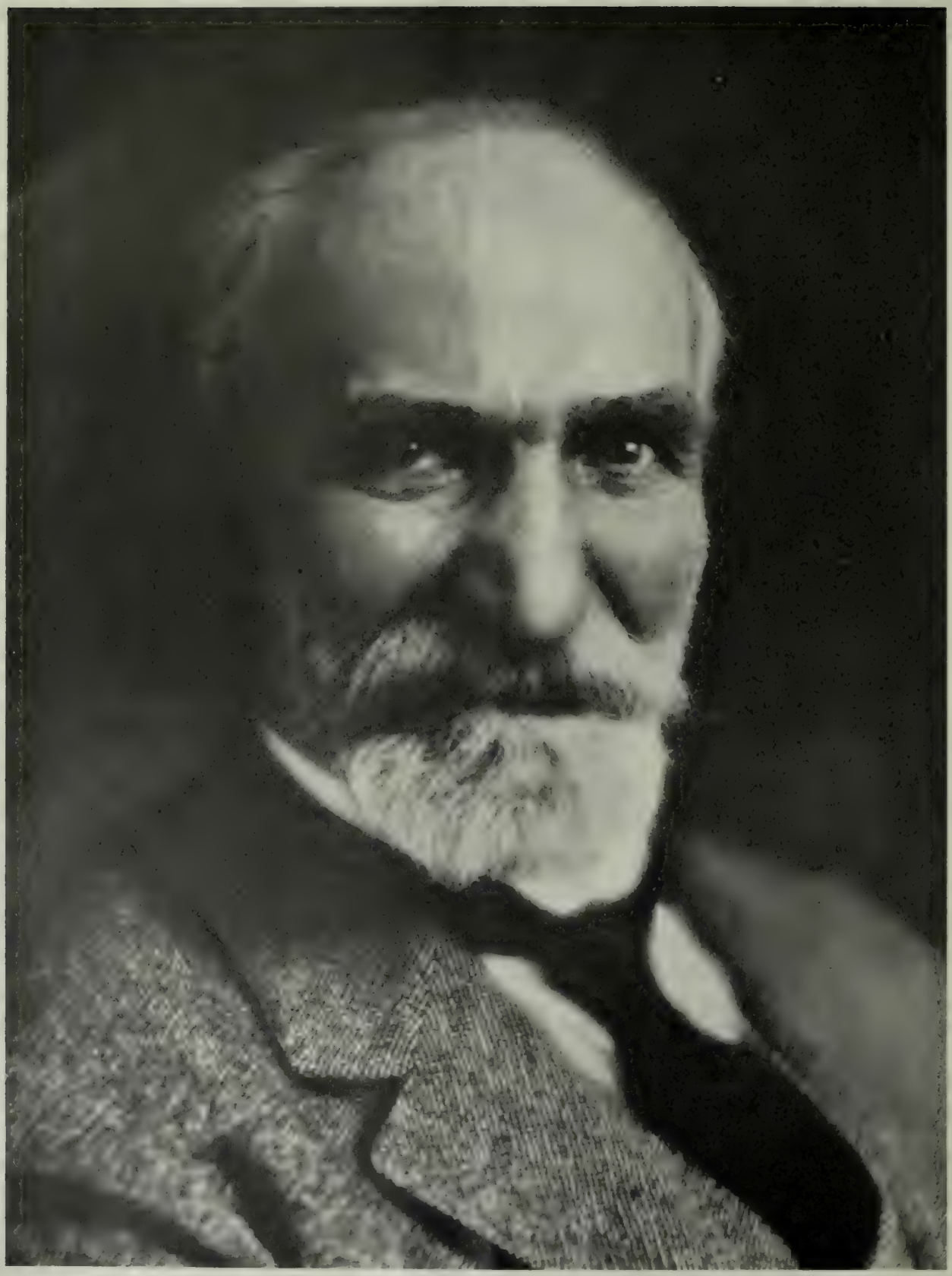
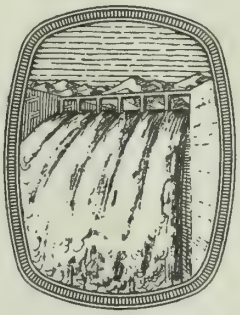


CHARLES DAVID MARX

Professor Emeritus of Civil Engineering at Leland Stanford, Jr., University, and chairman of the Committee on Arch Dam Investigations of the Engineering Foundation. Professor Marx recently accepted membership on the board of consulting engineers who will act in an advisory capacity on the design and construction of the San Gabriel River dam, Los Angeles County, Calif.

MODERN Irrigation

The Magazine of Applied Hydraulics



Volume III JANUARY, 1927 Number 1

The Progress *of* Irrigation

HERBERT HOOVER, Secretary of Commerce, pays tribute to the engineering profession in his new year's message on irrigation and reclamation, a message which credits the advance of engineering science with making the possibilities of the nation's water resources become a reality. Water development has passed definitely out of the dream stage, he says.

"We have," the Secretary declares, "emerged from the long postponement of national construction imposed by the war and reconstruction; we have recovered so greatly in national wealth that we now have the capital to compass such projects as our expanding needs require and our undeveloped resources make possible."

All this, he points out, has brought us to the threshold of a new era in utilization of these various resources of water where we must broaden our foresight and determine great policies and programs; and he adds:

"The great policy we need to adopt is a resolution of vigorous development. The program is a problem of each great drainage. We must no longer think in terms of single power sites or single storage dams or single land projects or single navigation improvements; we must think (and thanks to science and engineering we can think) in terms of the coordinated long view development of each river system to its maximum utilization."

Hoover calls attention, too, to the "political opposition and interstate quarrels, into the muck of which the development of our water resources are fast drifting and points out how these controversies could be solved by the determination of broad national programs. Many of the problems, he explains, being interstate, cannot be solved by a single local effort.

Dwelling on the loss that failure to develop the nation's water resources involves, Hoover declares that every drop of water that runs to the sea without yielding its full commercial return to the nation is an economic loss, and that this loss in all its economic implications can be computed in millions. While admitting that much effective work has been done with water, Hoover adds that vast sums of public money have been wasted under political pressures.

"We have now skimmed off the easy jobs," he declares. "Today it is the major engineering jobs and the opportunity of great national design which lie before us."

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The logic of Hoover's analysis of the Colorado River question cannot help but appeal to the people of the West, regardless of geographical location, political stamp or beliefs. The Secretary declares that "I know of no more perfect example of the need of determination of broad policies and of urgent execution of the first major engineering job than that furnished by the Colorado River."

"Here," he goes on, "we have a great river whose basin lies in seven states, presenting the possibility that, given adequate storage of its enormous spring freshets, we could eventually add to our assets between 5,000,000 and 6,000,000 acres of irrigated land and 6,000,000 horsepower.

Hoover concedes, of course, that there are a multitude of problems presenting themselves in this river system. There is, for instance, as he points out, the urgent need for immediate flood control to protect the already developed communities in California and Arizona. There is a need to provide storage for expansion of irrigation. There must be a provision of adequate domestic water supplies to Southern California and cities in Colorado. There is need for the large power supplies that will be the by-products of this development. There is need to determine that the works erected for these immediate purposes should be a part of the coordinated development of the entire river, and there must be a determination of the respective rights of the different states in their participation in the benefits from the river.

"I do not propose," Hoover says, "to enter upon the details of this complex question beyond the affirmation that the first step in this program—a great dam at Boulder Canyon and subsidiary works—is clearly an urgent and immediate necessity. It is one of the major water developments before us. I believe that in this case the entire outlay can be recovered from the sale of power and water. Many other steps will need to follow because there must be a score of great dams before the whole of the Colorado Basin can be developed and they may well require a whole generation for their completion. But above all, there must be a full coordination of development, so that any part undertaken, whether by the government, by the power companies, by states or by municipalities, or by the irrigation districts shall be a part of a complete scheme whose full realization will result in the maximum utilization of the river."

One of Nature's Storage Basins in a Western Irrigation District

A news dispatch from Washington states that opposition to the enactment of a bill introduced in the Senate proposing that the Federal Government cede the entire unreserved public domain to the states was expressed by Secretary Work of the Interior Department in a report submitted to the Senate Committee on Public Lands and Surveys in January.

Estimating that the royalty and sale value of the remaining lands and resources belonging to the United States total $13,697,500,000, not including water power possibilities with an annual income of $1,550,000, the Secretary declared that these resources should be retained, conserved and developed by the Nation for the general good under existing policies.

It was also pointed out by the Secretary that if, as proposed by this bill, all the public lands and resources are turned over to the States, it would mean the end of Federal reclamation and Federal conservation.

"By the act of June 17, 1902 (32 Stat., 388)," the statement reads, "all moneys, except the 5 per centum theretofore set aside by law to the States for educational purposes, were set aside and appropriated as a reclamation fund for the examination, construction, and maintenance of irrigation works in the western States. Since that time $208,217,325 has been expended by the Federal Government from this fund in connection with reclamation projects in the western States."

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Minority Report on San Gabriel River Project

THE proposed Los Angeles County, California, flood control dam on the San Gabriel River is meritorious, but the urgency is not so great that it should proceed until fully coordinated with the plans for the development of the river for other beneficial purposes, according to the heretofore unpublished minority report of the investigating commission appointed by joint action of the Secretaries of the Interior and Agriculture.

This committee, composed of F. J. Saffley, inspector, General Land Office, Salt Lake City, H. D. McGlashan, district engineer, Geological Survey, San Francisco and F. E. Bonner district engineer, Forest Service, San Francisco was named for the purpose of conducting a survey that would enable the government to make a decision on controversial points relative to the site for the proposed dam.

The minority report was submitted by Mr. Bonner.

The proposed San Gabriel Dam is one of the outstanding engineering projects commanding the attention of Southern California. Aside from its service as a flood control structure in the San Gabriel River, the dam would also serve for the storage of water for domestic and power purposes.

There are a number of conflicting plans regarding the usage of the waters, the rights connected with the different proposals and the site for the dam itself, and since a greater part of the land to be flooded by the impounded waters is the property of the government and is a part of the Angeles National Forest the committee of three was appointed by the two cabinet members, whose departments are directly involved, in order that they "may make such disposition of the matter as will best serve the public interests."

Pasadena Needs Water

In his minority report Mr. Bonner points out that the city of Pasadena is in immediate need of an additional water supply and is well justified in seeking a development of the San Gabriel under the water right priorities that have been acquired. The location of the proposed Flood Control District Railway for the construction of the dam at the Forks site, favored by the majority of the committee would, Mr. Bonner asserts, hamper and delay the Pasadena development, whereas at an additional cost to the district of about $450,000 the railway may be so located as not to interfere with the higher use of the land for domestic water supply.

"Suggestion has been made," the report reads, "that all interests would best be served by a cooperative dam constructed at the Granite Dike site where it appears that storage capacity equivalent to that proposed at the Forks may be provided for about $5,000,000 less cost."

The following additional excerpts from Mr. Bonner's report have been prepared for readers of Modern Irrigation.

Extent of Watershed

The drainage area tributary to the San Gabriel River is about 800 square miles, of which about a third consists of the rugged mountain watershed in the Angeles National Forest. Two forks flowing from opposite directions meet in the heart of the mountains to form the main river which then flows southerly first through 9 miles of deep canyon and then out across the San Gabriel Valley and coastal plain to the ocean. The mountain watershed is rough and inaccessible and therefore but little used except for recreation.

The runoff of the river is extremely irregular due to the steepness of watershed and the precipitation being concentrated mostly in severe storms of the winter months. Stream measurements made at the mouth of the canyon for the past 30 years by the U. S. G. S. show an average annual discharge of 122,000 acre feet, but with a range from 9,630 acre feet in 1898-99 to 410,000 in 1921-22. The largest daily discharge of record is 22,300 second feet with maximum crest of 40,000 second feet.

Proposed Development

The Los Angeles County Flood Control District proposes a 240,000 acre feet reservoir at the Forks for flood control and conservation purposes, while the city of Pasadena plans a 65,000 acre feet reservoir lower down for domestic supply purposes. The District also desires to build a construction railway up the canyon traversing the Pasadena reservoir. The cities of Long Beach and Whittier have applied for right of way for domestic supply reservoirs in the lower canyon but have made no showing of intention to proceed. A proposal has been made by Pasadena and others that a joint dam in the lower canyon, large enough for all purposes, offers the best solution of the problem.

According to the present plans, however, the Flood Control District railway location conflicts with the Pasadena reservoir and there is a possibility of operating conflicts between the two reservoirs, and also the Whittier and Long Beach applications conflict with Pasadena's project. The San Gabriel valley water users oppose the Pasadena

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Comparative Costs on Proposed San Gabriel Dams

Reservoir capacity 240,000 acre feet

Item	Granite Dike	Forks
Diversion and care of the river	$ 125,000	$ 125,000
Clearing reservoir site	75,000	75,000
Excavation (G. D. 950,000 c. y. @ $2.00) (Fks. 1,100,000 c. y. @ $2.00)	1,900,000	2,200,000
Disposal of excavation	250,000	50,000
Conc. aggregate (G. D. 5,400,000 t. @ 40c) (Fks. 7,200,000 t. @ 40c)	2,160,000	2,880,000
Cement (G. D. 542,000 t. @ $10.00 net) (Fks. 722,000 t. @ $10.00 net)	5,420,000	7,220,000
Mixing and placing conc. (G. D. 3,000,000 @ 75c) (inc. forms and curing) (Fks. 4,000,000 @ 75c)	2,250,000	3,000,000
Grouting and drainage wells	150,000	200,000
Outlet works in dam including trash racks, steel pipe, slide gates, balanced valves, etc. installed	250,000	250,000
Spillway and flood discharge tunnels	1,000,000	800,000
Inspection galleries, wiring, water seals, grout pipes, drain pipes and miscellaneous appurtenances	100,000	100,000
Construction equipment, towers, derricks, chutes, etc. installed	1,000,000	1,000,000
Warehouses, storage bins and terminals	350,000	200,000
Camp buildings incl. equip. and wiring	275,000	250,000
Water supply system	50,000	50,000
Contractors overhead expenses including superintendence, hospital operation, fire protection, camp maintenance, equip., repairs, fuel, small tools, air compressor operation, unloading and handling equip., machine and carpenter shop operation, storehouse expense, dismantling plant, electric power cost and misc. construction materials	1,750,000	2,000,000
Casualty and casualty insurance	330,000	400,000
Surety bond	275,000	325,000
Contractors margin incl. financing and other general costs	1,700,000	2,000,000
	19,410,000	23,125,000
Preliminary expenses incl. surveys, exploration, plans and specifications	200,000	200,000
Right of way (G. D. 850 ac. @ $400) (Fks. 500 ac. @ $400)	340,000	200,000
Engineering and supervision	400,000	450,000
Power lines, transformers, telephone lines, etc.	50,000	75,000
Railroad const. and operation	1,250,000	1,650,000
Contingencies (about 5%)	1,000,000	1,250,000
Interest during construction at 5%	2,500,000	3,250,000
Total Cost	$25,150,000	$30,200,000

est possible time in which they are well justified and it would appear that the proposed San Gabriel project would satisfy their requirements until the Colorado River supply is made available about 1940.

Such information as is available indicates that the Flood Control District engineers have over-estimated the flood possibilities of the river and that a capacity of 50,000 acre feet would be adequate for flood control purposes with a wide safety margin. Flood protection for the immediate future is desirable but the plans should be well considered and coordinated with other uses of the river before construction proceeds.

Comparison of Dam Sites

A dam creating 240,000 acre feet of storage at either the Forks site or the Granite Dike site would be an immense structure. The Forks dam would be much longer but not so high. The two dam sites are not essentially different from a geological standpoint and it appears that either one is suitable and safe for a high dam.

The Granite Dam site has not been explored by borings but foundation conditions seem to be substantially the same at both sites, although the Forks site would require about 150 cubic yards more excavation. The Granite Dike site is more favorably located for both flood control and conservation purposes on account of a larger tributary watershed. In regard to provision of suitable spillways the two sites are approximately equivalent. Aggregate for concrete would have to be transported from below for the Granite Dike dam, while at the Forks gravel may be obtained from the adjacent streambed. The cost of the aggregate production for either dam will not be materially different. The amount of material to be transported to the Granite Dike dam will be much greater on account of the aggregate, but due to the shorter haul the total transportation cost will be somewhat less. At the Forks site adequate space is available for camp sites, terminals, etc., while the more restricted conditions at Granite Dike will require considerable excavation to provide suitable facilities. The dewatering problem and diversion of the river will be about the same in either case.

There is some difference of opinion be-

(*Continued on Page 23*)

project, while the District's project is protested by various civic associations as being wasteful of public funds because of a mistake in selecting the site.

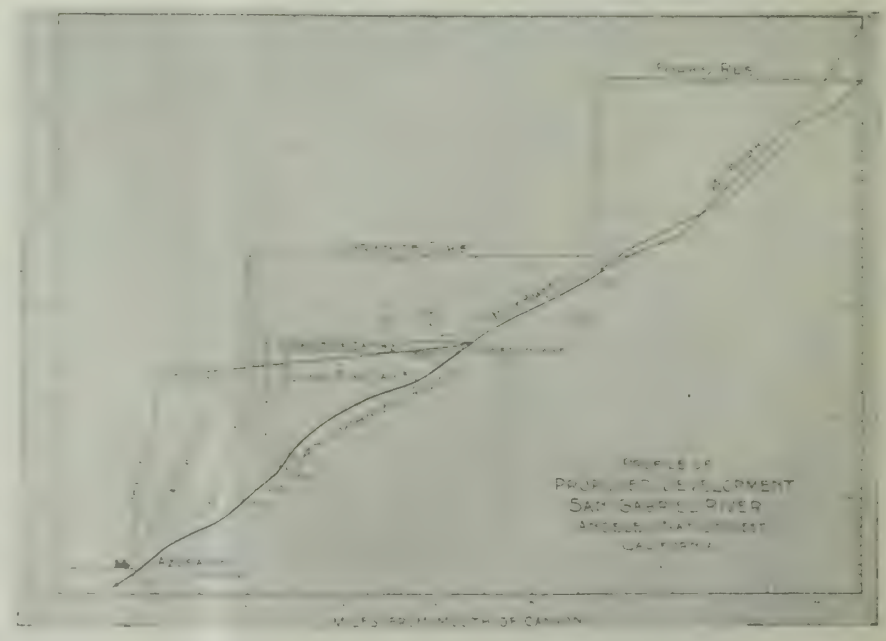
Pasadena Has Prior Water Rights

Pasadena has prior filings to appropriate, but these are contested by the valley interests on account of claimed lack of surplus water. The State Division of Water Rights has deferred decision pending a complete investigation, but the probable outcome appears favorable to Pasadena.

At the present time there are about 70,000 acres under irrigation by direct diversion or pumping from the main basin of the San Gabriel. Water levels in this basin have been receding somewhat, but not nearly so much as in the supplementary basins replenished by the smaller streams.

A population of perhaps 125,000 people obtain their domestic water supply at present from the underground supply which is mainly dependent upon percolation from the San Gabriel and tributaries. There has been no evidence offered to indicate that such supplies are inadequate.

Pasadena is in a serious situation concerning its water supply owing to the rapid recession of the underground basins from which the major part of the present requirements is produced. They have made efforts toward obtaining a new supply in the short-



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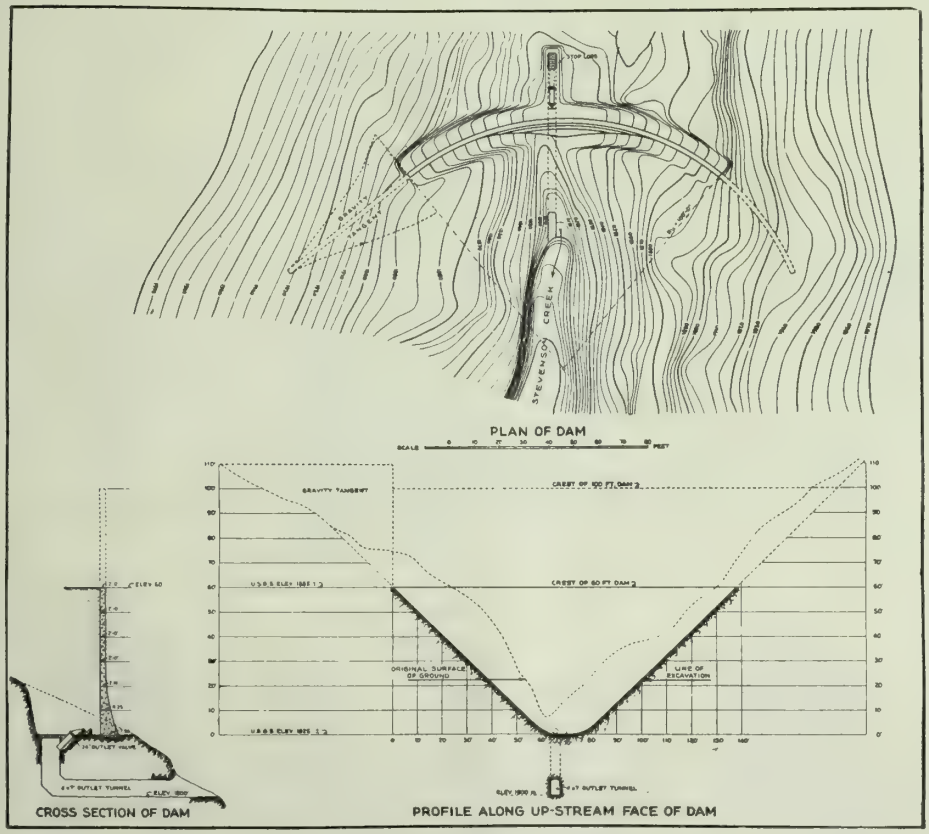
Experimental Arch Dam on Stevenson Creek, California, Withstands Heavy Flood Waters

Three Foot Crest Over Top of Structure Washes Away Galleries and Apparatus; History of Tests to Date

By GRAYDON OLIVER

ENGINEERS throughout the country have been greatly interested in the tests being conducted on Stevenson Creek, California, on the Experimental Arch Dam. This work is being carried on in co-operation with the Engineering Foundation. The dam is now completed and tests are in progress.

Arch type dams have been constructed for a great many years, but it has always been more or less of a hit and miss method of design, plenty of leeway being allowed by the engineer as a safety factor for the unknown quantities. The first arch dam of which there is any authentic record was built in India about 1800, and known as the Meer Allum. This is of the multiple arch type. The next arch type structure was built in France about 1845, known as the Zola Dam. The first American Arch dam of which there is any record was the Bear Valley Dam, built in the San Bernardino mountains in 1884, by F. E. Brown, a civil engineer of Los Angeles. Records show that the location picked out was approximately 70 miles from the near-transportation center, and all tools, cement, and supplies had to be hauled these 70 miles over rough mountain roads to the site of the dam. The capital available for financing the project was very limited, and in order to make as much of a saving as possible, Mr. Brown designed a structure which surpassed in boldness all other dams ever built. This structure owed its stability solely to the curved form of its plan, which enabled the wall to act as an arch, the profile being so thin that it could not resist the thrust of the water by gravity. This particular dam was curved upstream with a radius of 335 feet, and is about 300 feet long at the crest. The maximum height is 64 feet.



Plan, cross-section and profile of test dam to be tested to destruction by Engineering Foundation's Committee on Arch Dam Investigation.

Reasons for Experimental Work

Since the construction of the Bear Valley Dam, many arch type dams have been built, none of which has ever failed, simply because they were built with ample factors of safety. There has been no work done to determine the limit of this factor of safety, but it is possible that it may be reduced and still be consistent with factors of safety that are used for other engineering structures where the theories of design have been proved by experiment.

There are at the present time several conflicting theories of arch dam design, but there has never been any adequate experimental work done to establish any one of these theories, and as the greater number of all the hydraulic projects that have been undertaken in the past involve the arch dam as a major feature of their plan, it is extremely important that the design of the arch should be on the same scientific basis as other parts of the development. It was for this reason that the Engineering Foundation, which is an organization functioning under the direction of four of the larger engineering societies, and specifically devoted to research along engineering lines, undertook definitely to establish the experimental work necessary for further development and to test the various theories involved in arch dam design.

The placing of concrete in the Stevenson Creek Experimental Arch Dam began on April 19, 1926. This work was done in successive stages, five feet of concrete being poured the full length of the dam at each concreting stage. On June 4th, the last pour was made, making the total height 60 feet. Since that time a 24-inch wood stave pipe has been laid to conduct the water of the creek over the top of the dam when such water is not wanted in the reservoir. Valves and other control equipment necessary for withdrawing the water from the reservoir have also been installed.

While the concrete was being poured, hundreds of instruments, parts of instruments, and metal reference marks were

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VIEWS OF TEST DAM AT STEVENSON CREEK AND SOME OF COMMITTEE

(1) Flood waters over crest of dam. (2) Reading Telemeters and making Strain Gage Measurements. (3) Deflection being read and recorded. (4) Looking up-stream toward dam during flood period. (5) Wooden forms ready for the next five feet of concrete. (6) Looking up-stream at Stevenson Creek Arch Dam under test. The staging gives access to instruments. (7) Placing the last concrete to complete the dam to the 60 foot level. (8) Fred A. Noetzli, secretary of committee on tests. (9) L. C. Hill, consulting engineer. (10) Professor Charles D. Marx, chairman of committee on tests. (12) D. C. Henny, consulting engineer. (13) W. A. Slater, engineer of bureau standards. (14) H. W. Dennis, in charge of construction. (15) H. Hawgood, consulting engineer. (16) Looking up-stream toward dam during construction. (17) Ivan E. Houk, Bureau of Reclamation engineer. (18) Professor R. E. Davis, University of California.

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very carefully set in place to be used in measuring strains, deflections, and temperatures. Wooden trestles were erected to afford the observers access to all points of the dam. Electric lights were installed on both faces of the dam in order that continuous reading could be taken covering a considerable period of time. The last wooden forms in which concrete had been poured, were removed June 10, 1926.

Continuous Wetting Prevents Shrinking

Ever since the begining of the construction, the concrete has been kept wet by small streams of water which trickle from hose or perforated pipe down the faces of the dam, except when tests are in progress and when concrete was allowed to dry from June 25 to July 2 for special observation. By this continuous wetting undesirable shrinkage during the curing of the concrete was prevented. Examination showed the dam to be a highly satisfactory "specimen," accurate in shape and dimensions and free from objectionable defects.

Selection of materials and mixing and placing of concrete were carefully controlled to get a concrete of usual characteristics but as uniform in strength and density as was feasible. To this end the engineers in charge installed a Blaw-Knox "inundator," a device developed during recent years to control accurately the quantity of water and sand entering the mix and taking into account the moisture in the sand as received at the mixer.

Concrete's High Tensile Strength

The strength of the concrete has shown a high degree of uniformity. The average was slightly over 2000 pounds per square inch at 28 days. The strength aimed at was 1800 pounds per square inch at 28 days. A great many of the materials and equipment for the construction of the dam were furnished by the manufacturers without cost to the committee.

Testing Staff of Arch Dam Committee: Left to right, Glade Berry, L. J. Marchand, W. A. Slater, A. Y. De Yoe, Ingt Lyse, R. W. Carlson, J. Stout.

Various measurements and other observations were begun with the first steps of construction. Water was first let into the reservoir for test purposes, to a depth of 20 feet, on July 12. Successive tests were made with water 20 feet deep against the dam on July 15; 30 feet deep on July 19, July 23, and August 9; 40 feet deep August 28 and September 1; 50 feet deep on September 4, 8, and 11; and 60 feet deep (level with the top) on September 18, 21, and 22. With each test a full series of measurements was made with the reservoir filled to the desired level and empty. These tests were made at night, when temperature changes would be at a minimum during the long hours required for making and recording the many hundreds of measurements.

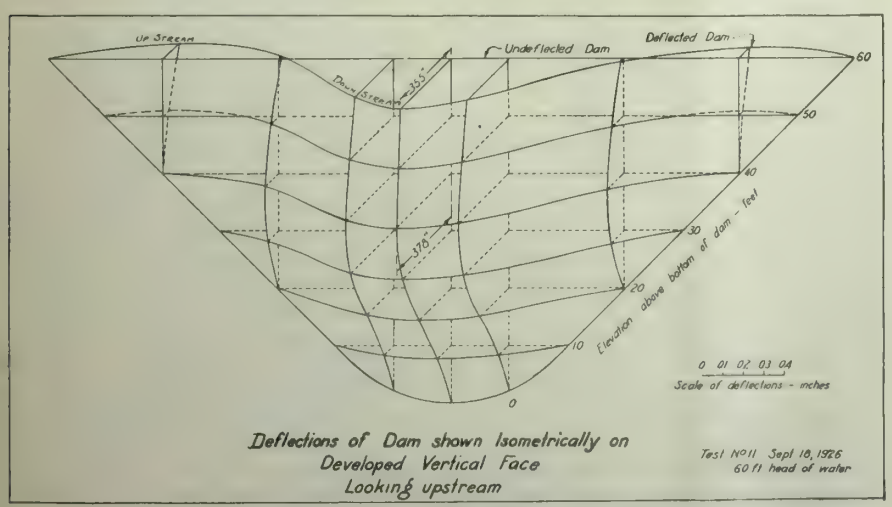
Measurements of strain and deflection have been successfully carried out. During the construction and curing period from April 21 until July 12 observations were made to obtain information on strains and deflections due to variation in temperature and moisture. These measurements served two purposes: they showed a marked response of the structure to variation in atmospheric conditions, and they assisted in the organization and training of an effective crew for carrying out the load tests which followed.

Instruments Measure Deflections

The strains derived from the measured deflections agreed with the strains measured directly with the strain gages and electric telemeters. Also, the deflections computed from the strain measurements agree reasonably well with the deflections measured directly. The deflections have been determined with an error generally not over .0005 inch. An isometric sketch of the developed vertical (upstream) surface of the dam as deflected with water 60 feet deep is reproduced herewith. It gives a conception of the deflected face of the dam and of the concordance of the measured deflections. The strains measured with the strain gages and telemeters have shown good agreement with each other. It has been possible to distinguish clearly between bending strains and those due to direct compression.

Under-water measurements of the opening of a crack at the base of the dam on the upstream side have been successfully carried out. The downstream movement of the foundation rock has

(*Continued on Page 36*)



Deflections of Dam Shown Isometrically on Developed Vertical Face Looking Upstream

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Western Nevada County, California, was once a gold center. Today the pick has given place to the plow. Airplane view shows orchard lands in vicinity of Grass Valley. Inset photograph shows Spaulding Dam, link in the power system by which the district expects to defray costs of delivering irrigation water at its boundaries. In the background, Zion Hill, where the Bowman-Spaulding conduit will terminate.

This Project Finds that Power Sales Pay Cost of Water

Nevada Irrigation District Uses Works of an Earlier Hydraulic Industry; Counts on Contract with Power Company to Pay Cost of Storing and Delivering Water

By RALPH G. WADSWORTH*, M. Am. Soc. C. E.

THE NEVADA IRRIGATION DISTRICT, California, has solved the problem of creating a cheap water supply for its lands in the face of numerous obstacles similar to those which are confronting practically all new irrigation projects in California and many others throughout the West. Furnishing of water for new projects was once little more than a matter of putting dams or pumps in the nearest stream and diverting the needed supply. This is true no longer. There is no water to divert. Even the Sacramento River, believed in the past to be an unfailing source, has carried during the last few seasons barely enough water to meet the needs of established irrigation projects, and its tributaries are in many cases perfectly dry in the summer months. Extension of irrigation to new lands at the present time can only be effected by producing artificial stream flow through regulation of winter runoff, which is still available in large quantities. The problem has become one of storing in winter, releasing in summer, and conveying to the point of use, all at a cost which the lands can carry.

The nature of this problem was realized fully six years ago by the agriculturists of western Nevada County, California. Theirs was a land of gently rolling foothills and sheltered valleys, capable of a high degree of horticultural development if watered periodically during the hot, dry growing season. But the numerous mountain streams passing their doors gave little promise of water for irrigation. Not only was the summer flow negligible, but even the heavy winter runoff was in process of being preempted for power purposes and diverted into distant watersheds. Under these conditions, the Nevada Irrigation District was organized and a comprehensive project outlined under the guidance of A. L. Wisker, Secretary-Manager and Fred H. Tibbetts, Chief Engineer. In the spring of 1927, after six years of effort, an abundant supply of water will have been provided at its boundaries practically free of cost.

Nevada County, in the past, has perhaps been best known for her gold mines. Many millions of dollars have been and still are being produced from the rich veins in the vicinity of Grass Valley and Nevada City. More spectacular were the great world-famous placer mines in the 60's and 70's when hydraulic mining was at its height. In a period of a few years, whole mountains of gravel were demolished by the force of giant jets of water and the widely distributed particles of free gold extracted by sluicing through long flumes.

The great depth and extent of gold-bearing gravels in Nevada County are the result of two great streams of the Neocene period which met near the present location of North Columbia on San Juan Ridge and flowed thence westerly in the direction of Smartsville to the gulf which occupied the Sacramento Valley, (see map on Page 17). One branch extended from North Columbia easterly and northerly, while the main stream extended in a southeasterly direction as far as the present Middle Fork of the American River, cutting directly across the drainage lines as we now know them. Subsequent upheaval and volcanic action completely altered the topography of the region. Recent streams, by cutting their beds down below the ancient river gravels, produced the drainage outlets

*Mr. Wadsworth is associated with Fred H. Tibbetts, of San Francisco, who serves the Nevada Irrigation District as its chief engineer.

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which made hydraulic mining possible.

Hydraulic mining on a large scale has been practically dead since about 1880, when it was stopped by a court injunction which perpetually restrained the North Bloomfield Mining Company from discharging mining debris into the Yuba River. This action was the outgrowth of damage being done to navigation and agricultural interests by the rapid accumulation of tailings in the lower rivers.

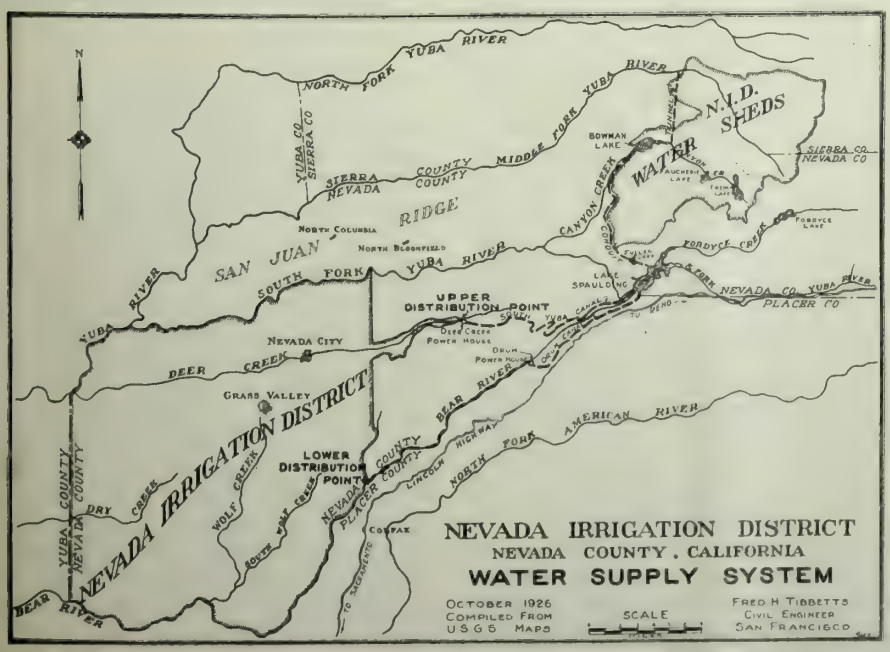
In the preceding twenty-eight years, from 1852 to 1880, mountain water supplies for the hydraulic operations had been developed by construction of numerous reservoirs and canals. Long tunnels were driven, unique flumes and daring siphons were constructed. Many eminent engineers were engaged on these truly remarkable works, among them Hamilton Smith, Jr., famed hydraulic experimenter. Although many of the canals have disappeared, most of the storage reservoirs are still intact. Ownership has been retained by the successors of the old mining interests until the present day. It is probably this fortunate circumstance which has made available to the irrigation district at the present time the reservoirs and watersheds of the old mining projects.

The Malakoff placer mine at North Bloomfield, Nevada County. This picture shows effectively the gigantic scale on which the hydraulic mining operations were conducted, and the lasting impressions made on the country's topography. These high banks are the result of the hydraulic operations which literally demolished mountains. Although mining activity stopped in 1880 in this vicinity, the works of the miners are today being used by their successors for irrigation.

The Plow Succeeds the Pick

Although mining, lumbering and cattle raising were the principal industries of Nevada County in the past, agriculture has come rapidly to the fore in the last few years. It has been clearly demonstrated that fruits of superior quality can be produced. Pears grown in the county were sold for record prices in New York during the past season. Alfalfa and field crops are successfully grown where irrigation water is available. Soils, climate and topography all indicate that Nevada County will duplicate the highly developed fruit section in the vicinity of Auburn and Penryn in Placer County one of California's most fertile sections.

The agricultural land of Nevada County occupies the westerly third of the county, at elevations below 3500 feet. When the Nevada Irrigation District was organized, all agricultural land was included except that lying north of the South Fork of the Yuba River, amounting to perhaps one-fifth of the total. The district, accordingly, includes all land in the western portion of the county between the Bear River on the south and the South Yuba on the north, an area of about 209,000 acres.



In selecting a source of water supply the district was limited to a rather narrow range. Local supplies were exhausted or inadequate and recourse to a more distant and expensive source was imperative. In the mountains, the headwaters of the Bear and South Yuba are clearly the nearest and most accessible and these rivers would seem to be the logical choice. Reference to the map calls attention to a most unusual topographic feature at the head of the Bear River. The Bear and the South Yuba at this point are not more than 2500 feet apart and separated only by a low saddle, scarcely 100 feet above the Bear but 300 feet above the Yuba. Study of the ground demonstrates clearly that the South Yuba has been guilty of geological piracy; that by eroding its bed rapidly in a soft formation it has at some time in the distant past undermined the channel of the Bear and robbed it of some 120 square miles of drainage area. Thus the Bear is now left with a channel much too big for its present flow.

Turning to Alternatives

This act of vandalism on the part of nature has been compensated, to some extent, by the works of man. For many years the headwaters of the South Yuba have been controlled by storage at Lake Spaulding and Lake Fordyce and the bulk of the regulated flow diverted into the Bear River basin where it is used by the Pacific Gas & Electric Company for power generation at plants in Placer County. The nature and extent of the power company's development put the Bear and South Yuba Rivers clearly beyond reach of the Nevada Irrigation District.

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The EDITORIAL

MODERN Irrigation

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The Colorado

CONGRESSIONAL discussion of the Swing-Johnson bill and the reports of these discussions in the daily press have again brought to the very forefront of public attention this subject of the Colorado River development.

Never has there been a water problem so difficult of solution, seemingly, as this problem of the Colorado. It has so many ramifications; and there is such a diversity of interests to be served. Flood control measures are necessary to protect developed communities in the Imperial Valley; a source of additional domestic water supply to Colorado and Southern California cities must be assured; there must be a fair determination of the respective rights of the several states involved; large power supplies must be developed.

Here is a big job, an urgent job, the accomplishment of which is becoming more and more of an immediate necessity. Advances in engineering science have made this major development possible, but the execution of the work is snagged on politics and sectional jealousies. Unfortunately the daily press, hedged about by political alliances and a perspective which envisions local needs to the exclusion of the needs of all, is of little help in making the development of the river a reality. An amazing misconception of the motives and beliefs of the fellow on the other side of the fence is possible from a study of any single paper; while attention to several journals only serves to make the issues more confusing to one who seeks the facts.

We do not propose to discuss the merit of the positions held by the various peoples involved in this question; or to offer solutions to the multitude of problems that must be worked out before the initial steps of this great development can be undertaken. We can only hope to impress again on our readers the necessity for the adoption of broad policies and a coordinated plan of development that will result in the greatest utilization of this resource. Harnessing of the river is inevitable, of course; a happy reconciliation of interests is the immediate hope.

The Silent Player

THE account of the Stevenson Creek arch dam experiments appearing in this issue calls to mind again the role of the engineer in the development of hydraulics. A silent actor in the drama of irrigation and reclamation he stands for the most part behind the scenes unseen and unknown to the vast audience which views his works and knows little or nothing of the hours of painstaking experiment and planning which must precede the accomplishment of his plans.

The Stevenson Creek tests are being conducted to bring, if possible, some definite theory from the mass of conflicting opinions regarding arch dam design. The importance of the work can be appreciated from the fact that the majority of hydraulic projects to date have involved the arch dam as a major feature of their plan.

To the Engineering Foundation, a research organization formed from four of the country's engineering societies, must go the credit for the plan to place arch dam construction on a scientific basis. This group has undertaken the experimental work necessary to the establishment of definite theories of arch dam construction. The best minds in the profession are giving time and thought to this research in order that all may benefit.

Herbert Hoover says that we have been blessed by Providence with resources in water greater than any nation in the world. It is through the unsung efforts of the engineer, through the advance in engineering science which his research has effected, that the possibilities of these resources have become a reality, not a dream.

Good Management—Cheap Water

THE story of how the Nevada Irrigation District in California has used the works of an earlier placer mining industry and an agreement with a power company in such a way that the sale of water for power purposes will pay the district's irrigation water costs is interesting; but the possible applicability of such a plan in other localities is what will particularly appeal to other districts, already formed or in the making, which

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POINT *Of* VIEW

find that water costs leave no profit from the land.

The plan in full is told on another page in this issue, but the phase particularly worthy of comment is the way in which the power possibilities of the district's water supply have been utilized to the utmost. The total revenue received will average over $400,000 per year, an amount sufficient to pay the interest and amortization charges on the whole investment in the mountain storage works as well as operating costs, so the delivery of water at the district's boundaries can be considered as free of charge to the landowners. The land will, therefore, only have to stand the cost of local diversion works and distribution canals.

Such an advantageous arrangement was not obtained without a great deal of well directed effort on the part of the district's management. As a matter of fact several years were spent in bringing the plan to the point of operation. After all, the best of natural advantages cannot be used to the utmost without an intelligent understanding of their possibilities by those in charge. More projects have been a disappointment through lack of proper direction than through lack of natural resources.

Progress in Utah

THE contract which has been entered into between the United States and the Weber River Water Users' Association for the construction by the Bureau of Reclamation of the First Division of the Salt Lake Basin irrigation project, Utah, is a milestone in the state's irrigation development, while the extent of the benefits of the contract and the practicability of certain of its features may seem debatable points to some, yet the contract's desirable features far outweigh any drawbacks it may have.

The first division of the project comprises the construction of the Echo storage dam and reservoir on Weber River with a capacity of 74,000 acre-feet of water, and a diversion canal from Weber River to Provo River, at an estimated cost of $3,000,000. The construction was definitely approved by President Coolidge after a finding of feasibility by the Secretary of the Interior, based on a searching investigation of water supply, engineering features, cost of construction, land prices, probable cost of development, the adaptability of the land to settlement and farm homes, and the probable return to the reclamation fund of the cost of construction.

The development authorized will benefit about 80,000 acres of irrigable land in the counties of Summit, Morgan, Weber, Davis, Wasatch, Utah, and Salt Lake, Utah. All of this land is colonized and settled, and a supplemental or late season water supply will be provided. The soil consists of loam, clay loam, and sandy loam. Good crops of alfalfa, sugar beets, wheat, fruits, canning produce, and other crops common to this altitude are raised. Excellent marketing and transportation facilities exist.

The contract now entered into with the Weber River Water Users' Association provides for repayment of the cost of the project on the basis of twenty equal annual installments, the first installment to become due and payable on December 1 of the year in which the Secretary announces the completion of expenditures. The average construction cost of this division of the project will probably be about $40 an acre, making the average yearly payment $2 an acre. To this will be added the annual expense of operation and maintenance.

The total yearly charge will not be greater than the irrigators can pay, and it is believed that the additional water supply will increase incomes so as to enable the irrigators to meet the required payments on the project. The favorable conditions on the project amply justify the belief that the cost will be fully returned to the United States.

Help for the Red Man

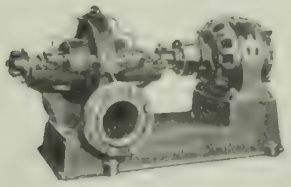
THE survey of irrigation methods and practices on Indian projects under the Federal Government in the West, which has been arranged by Secretary Work of the Interior Department, should be a revelation in irrigation management and eventually of real practical benefit to the settlers on the projects.

The investigation will go into the engineering and economic phases, with a view to improving the condition of the Indian farmers and the white settlers on the project lands. An irrigation engineer, selected by the Commissioner of Reclamation of the Interior Department, will investigate and report on the engineering features, and an agricultural economist, designated by the Secretary of Agriculture at the request of the Interior Department, will inquire into the economic feasibility of the projects. The Commission of the Bureau of Indian Affairs will detail an irrigation engineer from his bureau to assist the other two specialists.

The survey will cover construction costs and collections, operation and maintenance returns, failure to make repayments to the Government of capital invested, utilization of irrigated lands by the Indians, settlement of Indian lands by whites, water supply, soil fertility, availability of markets and other questions involving the feasibility of reclaiming lands on Indian reservations.

Records of the Bureau of Indian Affairs show that there are about 150 irrigation projects on Indian lands but only 17 of these may be classed as major projects. Approximately $26,000,000 has been expended in their construction, which, with an additional expenditure of approximately $8,000,000 for operation and maintenance, brings the entire investment to about $34,000,000. Under the circumstances a survey seems in order, both for the benefit of the settlers and those who pay the bills.

"Western Waterworks" Begins on Page 25



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Three-Fold Benefit Seen in Wright Irrigation District Act of 1897

Communities Have Shown That They Can Carry Out Big Water Enterprises; Law is Equitable

By L. L. DENNETT

State Senator, Modesto, California

THE passage of the so-called "Wright Irrigation District Act" of 1897, under which more than one hundred California irrigation districts are successfully functioning, marked one of the most important epochs in the political as well as the economic history of California. So successful and satisfactory has this legislation proven, that sixteen other arid and semi-arid Western States have enacted irrigation district laws patterned after the Wright Act, the constitutionality of which has been sustained by the United States Supreme Court.

Along three separate lines, its public benefit has been and will continue to be increasingly shown.

In the first place, it has demonstrated that rural communities are capable of undertaking and successfully carrying out, under State supervision and control, great constructive public enterprises. Cities have been almost universally successful in operating their waterworks and these districts are object lessons in the propriety of adopting the same general principles in agricultural communities.

Successful Projects

The Modesto, Turlock, South San Joaquin, Oakdale, Waterford, Merced, Imperial, Fresno, Anderson-Cottonwood, Glenn-Colusa and many other districts have financed and constructed vast water systems, and, in several instances power as a by-product, as successfully as any city or private corporation undertaking. Despite early and prolonged litigation, which vastly increased the cost of the older systems, they own and operate today the most extensive and efficient plants in the State, and are delivering water to the consumer at a reasonable cost. The money affairs of these districts have always been handled with honesty and integrity.

In the second place, this law has acted as a beneficial restraint upon the monopolization of land, and, to a degree at least, has brought about a condition resulting in great public benefit, because in these districts no one individual or interest can long afford to hold more land than he can cultivate. This because all land in each district must stand its share, according to assessed valuation, of the cost, whether water is used or not. One serious detriment to the State, in the early days, was the many large holdings of land by persons who would neither improve nor sell, thus depriving the people at large of their right to the greatest benefit possible from our natural resources.

Educational Influence

In the third place, it has placed these farmers comparatively free from dependence upon capitalistic enterprises, and also has brought to these agricultural communities many of the broadening influences, which usually exist only in our cities.

As an educational factor, their influence can hardly be overestimated. One of the fundamental principles of self-government is the recognition of the individual duty voluntarily to surrender certain personal privileges for the public good. This is one of the hardest things for men to learn. Another thing is the recognition of the responsibilities and duties of the individual voter.

To the farmer living in an irrigation district, the capable management of the works is of the utmost importance. He comes closer to the machinery of this government and would, personally, lose money through misgovernment, more directly than in any other public affair.

No Place for Selfishness

This municipal organization provided for the running of these districts, necessarily means the surrender of many individual privileges and liberties, and the assuming of obligations by which the community, as a whole, is advanced. But such relinquishment of individual rights and acceptance of obligations is often necessary for the success of the community undertaking, and these communities have, with candid common sense, accepted this fact, and have learned a most valuable lesson in self-government.

The importance of the proper management of the affairs of the district, calls from the individual voter, the most careful scrutiny of district affairs, and usually makes of an otherwise uninterested man, a responsible and thoughtful citizen. It is a bread and butter matter with him, and cannot be neglected however much he may be willing to neglect other public duties. Responsibilities are broadening in their effects, and liberalizing in their tendencies, and

"Western Waterworks" Begins on Page 25

these communities which have successfully carried out enterprises of such magnitude, can never sink into mere commonplace indifference.

In my opinion, this law provides the most just and equitable method for the management and operation of irrigation systems, of which we have any knowledge. Its lack of complete success in a few minor localities is because of economic causes, rather than any defects in the law.

Bondholders Protected

Time may suggest a need to amend the law in certain ways, but attorneys are agreed that as the Wright Act now stands, the legal remedies of bondholders are much stronger and better in the case of irrigation district bonds, than general county and city bonds.

The Wright Act puts a premium upon development and improvement, and a penalty upon slothfulness and selfishness. It is perpetuating to the people and their children a great opportunity and a great heritage. The people's greatest birthright in arid and semi-arid regions is made possible and shall be preserved, to be administered by the very people whose birthright is involved.

Water-Power Project Planned

Application for a preliminary permit to construct a water-power project in Yavapai, Mohart and Yuma counties, in Arizona, has been announced by the Federal Power Commission. The project as planned is to consist of a storage reservoir on Kirkland creek, division dams and a power house on Bill Williams river. The developed power is to be used for municipal, industrial and irigation purposes.

Ask Permit for Charleston Dam

Another important Arizona irrigation project began to assume tangible form when an application was filed recently for a permit to build a storage and irrigation dam at Charleston across the San Pedro river. An irrigation district, it is reported, will be formed next year, and an electin held, probably in July, to float a bond issue, now estimated at $2,000,000.

Completes New Pipe Line

A riveted steel pipe line 24 inches in diameter and over 7 miles long has just been completed for the Mutual Irrigation Company. This line runs from wells between Redlands and Beaumont, California, across San Timoteo canyon, to the Moreno valley. The line, together with distributing lines, represents an investment of about $500,000 and involves over 1000 tons of steel plates.

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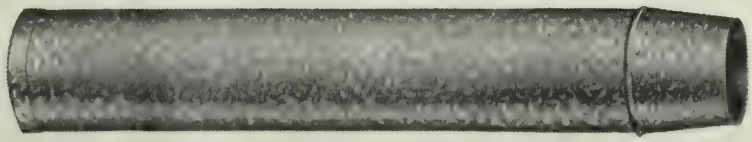

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"Western Waterworks" Begins on Page 25

This is the outlet of the old Bowman Dam. The date visible on the outlet is the date at which it was enlarged (1876). Many California engineers will recognize, in the picture, M. M. O'Shaughnessy, consulting engineer on dam construction.

This Project Finds That Power Sales Pay Cost of Water

(*Continued from Page 17*)

The American River watersheds to the south being out of the question, because of lack of storage sites and impracticable conduit location the search for a water supply was necessarily concentrated on the areas north of the Lake Spaulding development. The headwaters of Canyon Creek a tributary of the South Yuba, has been partly developed by reservoirs constructed by the dydraulic miners. Bowman Lake, the largest in the vicinity was created by the construction of two dams, in 1872 and enlarged in 1876. Dams at French Lake and Faucherie Lake were built somewhat earlier. These works were available to the District through purchase but investigation showed that the total water yield would not be sufficient for the district's needs. It was, therefore, necessary to go still further north and to tap the headwaters of the Middle Yuba, diverting the runoff from about 46 square miles through the ridge southerly into Canyon Creek. The total watershed area thus outlined was about 90 square miles.

Procedure to obtain necessary water rights was instituted early in the district's history. A very sharp conflict occurred, respecting particularly the Middle Yuba Water, with two power companies which proposed to construct series of power plants on the North Yuba and South Yuba, respectively, terminating at elevations far below the district's lands. Realizing that the loss of this water would forever deprive Nevada County of an essential part of its irrigation supply, the district made a determined stand and, after four years of discussion and negotiation, was finally successful in obtaining from the California Division of Water Rights and the Federal Power Commission permits on all of the principal streams applied for.

The plan adopted by the district to utilize the water supply thus acquired provides for a tunnel from the Middle Yuba to Canyon Creek, reconstruction of the Bowman dams on a much larger scale, construction of a conduit 10 miles long from Bowman Reservoir to Lake Spaulding and the installation of diversion canals and distributing ditches within the district's boundaries. The apparent gap in this program between Lake Spaulding and the District's land is to be bridged by the utilization of existing conduits of the Pacific Gas & Electric Company. The terms under which this arrangement is made possible are fully covered in a contract between the district and the power company executed on April 29, 1924. The contract itself

This typical view of the watershed of the Nevada Irrigation District indicates the character of the topography, and shows French Lake, a reservoir built to serve the hydraulic mining industry in 1859.

is somewhat involved but the basic principles are readily stated.

Principles of Agreement

The district agrees to deliver a uniform flow of 200 cubic feet per second to the power company at the margin of Lake Spaulding between July 1st and March 30th of each year and is permitted to deliver water during the remaining three months if desired. The company on the other hand agrees to convey and return to the district at its easterly boundary an equivalent amount of water, less certain specified conveyance losses. Return delivery will be made at two rather widely separated points: the upper distribution point at Deer Creek and the lower distribution point at Bear River. This real and essential service to be rendered by the company is, however, by no means the only or even the principal advantage received by the district. In addition, a very substantial cash rental is to be paid for the use of the water *en route*.

The reason for this is readily appreciated when it is realized that the elevation of the Lake Spaulding delivery point is 1668 feet above the upper distribution point and 3579 feet above the lower distribution point. These differences of elevation make possible the generation of very valuable amounts of hydro-electric power, while district water and power plants already existing will immediately produce a large part of the possible total.

Water destined for the upper distribution point will pass through two plants at the Spaulding Dam, thence by way of the South Yuba Canal to Deer Creek plant, discharging there into Deer Creek. Water for the lower distribution point will pass through the upper of the two Spaulding plants and thence by way of Drum Canal to Drum power house and the Bear River. Surplus water in the Bear, if not needed by the district, may be rediverted to the south and utilized through still other plants in Placer County. It is also planned that the power company will construct certain new plants, one at the margin of Lake Spaulding, to make use of the drop from the end of the district's conduit, and one or two additional plants on the Bear River.

Power Pays Charges

The district, for the use of its water by the power company, will receive an average rate of $3.14 per acre foot for all water used through the lower power houses, plus $30,000 annually for power developed at the new Spaulding plant. The total revenue thus received will vary somewhat depending upon the seasonal yield of the mountain watersheds but will average over $400,000 per year. As this will be sufficient to pay the interest and amortization charges on the whole investment in the mountain storage works as well as operating costs, the delivery of water at the district's boun-

(*Continued on Page 40*)

Bowman Lake, prior to its enlargement by the Nevada Irrigation District. This lake was created in 1872 by the construction of two dams, and its waters were used in hydraulic mining.

"Western Waterworks" Begins on Page 25

Minority Report on San Gabriel Dam

(*Continued from Page 12*)

tween engineers regarding the most suitable design for the Granite Dike dam, and it would appear advisable to adopt the straight gravity type if a curved design had to meet the severe conditions of the theories advanced by the Flood Control District engineers.

Various estimates of the volume of concrete required for each of the dams differ widely, but careful calculation with due regard to shaping of foundations indicates that the Forks dam will contain about 4,000,000 cubic yards and the Granite Dike about 3,000,000.

The cost of the Granite Dike dam is estimated at approximately $25,000,000 as against $30,000,000 for the Forks. It may be expected that construction of the latter dam will consume six or seven years while the Granite Dike dam may be built in from five to six years.

Storage Requirements

Studies by Davis and Sonderegger showed that a storage capacity of about 200,000 acre feet would be adequate for regulating the river. Hydrographic studies in connection with this report indicate that such capacity will thoroughly meet the needs of flood control, irrigation, domestic supply, and spreading regulation. The aggregate storage of 305,000 acre feet proposed by the Pasadena and Flood Control District projects is therefore, considerably in excess of the requirements. Sedimentation of the reservoir space will probably not create a serious problem within the next fifty years, and therefore warrants no provision for meeting the problem now.

Objections and Legal Situation

Materials for the Forks dam may be transported by a railroad located above the proposed Pasadena reservoir at a cost to the District of not over $450,000 more than the cost of transportation by railroad location in the bottom of the canyon. The latter would postpone operation of the domestic supply reservoir for a number of years. The larger part of the area in each of the proposed reservoirs consists of government land in the Angeles National Forest which is to a considerable degree affected by existing power withdrawals.

Impartial legal opinion indicates that the Pasadena project is not likely to be seriously impeded by threatened litigation, and that construction is likely to proceed after water right permits are issued by the state.

Legal information indicates that there is serious question regarding the qualification of the District under the Acts of 1891 and 1898, and that it would be more proper for any authorization to be made under the Act of February 15, 1901.

Restrictive interpretation of the Flood Control District organic act by the District officials prevented agreement being reached for joint storage in the Forks dam. It seems probable that these legal technicalities could be overcome in case a joint dam is found to offer the best solution for the river development.

In conclusion to his report, Mr. Bonner states:

The control of San Gabriel River floods by storage in the Canyon is desirable and necessary in the public interest, but not of such immediate urgency that the project should be undertaken without regard to proper coordination with development of the water resources of the river for other beneficial purposes.

Conservation of the surplus flow of the river by regulation and spreading, as proposed by the Flood Control District, to accomplish replenishment of the underground water supply of the San Gabriel basin is a meritorious project which will be of great benefit to the water users of the valley. Also such conservation might be employed to supplement storage for surface diversion by restoring to underground sources over a period of years as large or larger quantities of water as would have percolated from the natural flow uninterrupted by proposed reservoirs.

Pasadena has outgrown its present sources of water supply and is warranted in developing a new source in the shortest possible time. The City has acquired a lawful water right priority on the San Gabriel, and this source may be developed economically to meet the requirements pending expected completion of the Colorado River aqueduct by 1940. It is likely that the Pasadena project may proceed unhindered by threats of injunction as soon as a water right permit is issued by the State.

Railroad Location Interferes

The location of the proposed construction railroad for the Forks dam in the bottom of the canyon would seriously interfere with construction of the Pasadena reservoir and quite likely delay beginning of operation for four years or longer. Public policy in California recognizes the principle that domestic supply reservoirs constitute a higher use than railroads, and provision of transportation facilities above the reservoir flow line is entirely feasible. Considering the contribution offered by Pasadena, the added cost to the Flood Control District would be less than $450,000.

The Forks dam and reservoir constructed to capacity of 240,000 acre feet will cost about $30,200,000. A dam providing the same capacity may be constructed at the Granite Dike site for approximately $5,000,000 less. As to foundations and geological conditions the two sites seem about equally suitable and safe for a high dam, but the Granite Dike site is situated slightly more favorably for maximum flood control and conservation.

From hydrographic studies it appears that storage capacity of 200,000 acre feet will adequately serve all purposes in the development of the water resources of the river, and only a small amount of water would be wasted to the ocean under the most extreme conditions. Obviously, therefore, the aggregate capacity of 305,000 acre feet contemplated by the separate District and Pasadena projects is considerably in excess of requirements, and if both are constructed more than $10,000,000 will be expended for capacity for which there is little or no justification.

Power Withdrawals a Factor

All projects proposed are affected to a more or less extent by existing power withdrawals. None of the applications may, therefore, be approved except on a finding by the Federal Power Commission that the proposed use of the land coordinates with a plan of development best adapted to comprehensive utilization of the water resources for beneficial public purposes.

There is a serious question whether the Flood Control District is a properly qualified applicant for easement pursuant to the Acts under which application for the Forks reservoir has been made, and it would appear more proper for the District to seek permit under the Act of February 15, 1901.

The existing Azusa power development of the Southern California Edison Company, operating under permit issued pursuant to the Act of 1901, would be interfered with by the construction of either the Pine Canyon No. 2 reservoir or the Granite Dike reservoir. Conflict in the former case would not be serious and could be adjusted at reasonable expense. In the case of the Granite Dike, however, it would probably be best to substitute a new plant at the base of the dam. The larger output of such plant would apparently justify the cost of the new installation, as well as redeem the present value of the abandoned plant.

Cooperation Essential

The State of California through the Division of Engineering and Irrigation of the Department of Public Works is now engaged in a study for the purpose of determining the best use of the water resources of the San Gabriel river. However, on account of limitation of funds the State will be unable to thoroughly explore the foundation conditions at the Granite Dike dam site concerning which, probably more than anything else, definite information is essential for conclusive determination of the major questions involved.

Lack of complete cooperation between the various public agencies seeking to develop the resources of the river is certain to result in confusion, conflict and much wastetful expense. The need for coordinated effort was emphasized nearly two years ago by General Goethal's report (F.C. Ex. No. 16) to the Board of Supervisors on the Flood Control project in the following words:

> "These instances show an unfortunate lack of cooperation and in case of San Gabriel, with three separate interests, each important, some way should be found to bring them together. I believe that by a combination of forces and resources, a solution can be worked out which will satisfy the requirements of each, and which will result in economy and in ultimately expediting the work."

From all evidence now available, it would appear that the plan best serving all purposes and the public interest would be for the various agencies to join in the construction of a cooperative reservoir. If the foundation conditions at Granite Dike are found by exploration to be as satisfactory as surface conditions indicate, a dam at that point creating capacity of 200,000 acre feet would entail a total outlay of public funds about $15,000,000 less than the $35,000,000 required for the two projects now proposed constructed independently. In view of such vast potential savings certainly the Federal Government is warranted in withholding action pending definite determination of the most practicable solution which best serves the public interests involved.

New Siphon for Bakersfield

A 66-inch corrugated iron siphon has been recently installed in Bakersfield to carry waters in the Kern island canal under Nineteenth Street. The old siphon, constructed years ago, was brick lined and had started to leak. The new 66-inch iron lining was inserted within the brick walls to prevent leakage, which would eventually have undermined and destroyed the pavement, the city manager said.

"Western Waterworks" Begins on Page 25

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Following is the Report of Internal Pressure Tests Made by G. T. McIntyre, Inspector for Laguna Beach (California) Water District; J. B. Lippincott Co., Engineers:

Dia.	Nos.	Wall Thick-ness	Cem.	Mixture Sand	Rock	Age days	Working Pressure in Line	Tested To	Seepage
27″	20	2⅝″	1.0	2.3	½	14	55 lbs.	110 lbs.	none
27″	26	2⅝″	1.0	1.0	1.0	14	55 lbs.	110 lbs.	none
27″	3	2⅝″	1.0	2.3	none	16	55 lbs.	110 lbs.	none
27″	17	2⅝″	1.0	2.3	none	15	55 lbs.	110 lbs.	none
27″	37	2⅝″	1.0	1.0	1.0	15	55 lbs.	105 lbs.	none
27″	1	2⅝″	1.0	2.3	1.4	17	22 lbs.	85 lbs.	none

Note: None of specimens failed at above pressures. All pipe were tested 10 minutes at 10 pounds and 20 minutes at the high pressures without seepage. All pipe were selected at random by the engineer and tests are shown on all pipe so selected.

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"Western Waterworks" Begins on Page 25

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Says San Gabriel River Storage Basin Would Solve Pasadena's Water Supply Problem

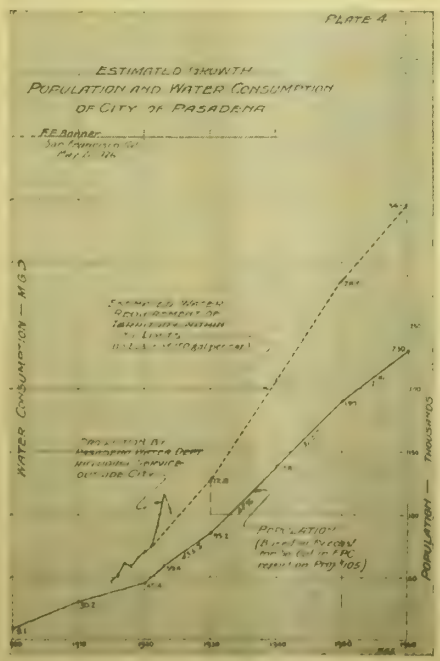
F.E.Bonner's Report StressesN ecessity for Assured Water Supply San Gabriel Will Do Until Colorado Acqueduct is Built

By F. E. BONNER*

ONE of the most important questions at issue in the San Gabriel (Los Angeles County) Dam controversy concerns the maximum storage capacity economically warranted for effective control of the San Gabriel flow, not only for flood protection but for other beneficial purposes. Pasadena proposes a 65,000 acre foot reservoir, which it would operate for domestic supply and to restore to the underground basin of the valley a volume of water equivalent to that which would have percolated had not the Pasadena reservoir interrupted the natural flow. The space would perhaps be about equally divided between the two purposes.

The Flood Control District proposes a 240,000 acre foot reservoir designed for flood control and general conservation purposes. According to plan set forth in Mr. Reagan's report of April 1, 1924 (p. 6 F. C. Brief of April 29, 1926) used as the basis for the bond election, the conservation feature of the project will be exclusively in connection with replenishment of underground water supply. Apparently the selection of the 240,000 acre feet of capacity was made on the basis of what a dam of certain height would provide rather than on a study of the storage requirement for some definite plan of operation (Tr. p. 1682-84).

The only plan of operation advanced by the District to justify such large capacity is the Hawgood and Bell plan of reserving 128,000 for flood control and utilizing the remaining 112,000 acre feet for conservation. They estimate that the accumulation of detrital material in the reservoir will rapidly diminish this conservation capacity. Apparently, the District's plan wholly disregards the lesser capacity required for equivalent regulation if the Pasadena dam is built (Tr. p. 1482), and likewise, the Pasadena plan disregards the regulating effect of the proposed District's reservoir.



Obviously, the operation of the two must be closely coordinated to avoid constant conflict, waste of water and useless capital expenditure. The aggregate capacity of 305,000 acre feet proposed for the two reservoirs appears considerably beyond reasonable requirements which may be justified on economic grounds.

State Studies Problem

The State of California, through the State Department of Engineering, is now engaged on a comprehensive water resource study, which as stated by Paul Bailey, State Engineer, (Tr. p. 727-28) includes investigation of the San Gabriel River with the object of determining the best plan of development. This study deals comprehensively with the question of storage requirements, but definite conclusions will not be available until the completion of the work during the current year.

Two plans have been advanced for reservoir operation on the San Gabriel River. The first plan contemplates a reservoir of 150,000 acre feet capacity, with 50,000 acre feet devoted to flood control, 40,000 to domestic supply regu-

*Mr. Bonner is District Engineer in the U. S. Forest Service at San Francisco. The accompanying article is an excerpt from his minority report to the government on the proposed San Gabriel dam.

Pasadena Water Department Operation
Compiled from 1924-25 Report
(In Acre Feet)

Fiscal Year	Production			Consumption	Loss	% Loss
	Pumped	Gravity	Total			
1915-16	1,080	5,368	6,449	5,345	1,104	17.1
1916-17	917	4,927	5,844	4,842	1,002	17.1
1917-18	2,305	4,600	6,905	6,081	824	11.9
1918-19	2,824	3,802	6,626	5,643	983	14.8
1919-20	4,218	3,268	7,486	6,430	1,056	14.1
1920-21	4,562	3,300	7,862	6,800	1,062	13.5
1921-22	3,615	4,839	8,453	7,115	1,338	15.8
1922-23	2,788	7,396	10,184	8,794	1,390	13.7
1923-24	10,121	2,868	12,989	11,085	1,904	14.7
1924-25	10,103	1,265	11,368	9,794*	1,574	13.9

Ten year increase—106%, about 7.5% annual compounded.
Consumption 1924-25, 426,625,000 cubic feet (9794 a.f. or 8.7 M.G.D.)
Number of services increased from 20,243 at beginning to 21,991 at end of year.
Estimated on basis of 4 persons to service, consumption equalled 103.8 gal. per capita per day.
*1924-25 consumption decreased by restrictions on use; 1923-24 per capita consumption 129.4 gal. per day.

lation, and 60,000 to spreading regulation. Prior diversion rights for irrigation, up to 5,000 acre feet per month, would be left undisturbed. Such a reservoir would control all floods with a wide margin. In addition, it would support a domestic supply draft averaging 22,000 acre feet annually and regulate practically all the surplus flow for spreading at a rate not in excess of 1,000 acre feet. The total quantity wasted, or rather, discharged at rates greater than 1,000 acre feet over the entire 30 year period amounts to about 100,000 acre feet, or less than 3 per cent of the total flow.

The second plan contemplates a reservoir of 200,000 acre feet storage, with 50,000 reserved for flood control, 75,000 for regulating the supply for irrigation and domestic use, and 75,000 for spreading regulation. Although storage for irrigation through gravity diversion is not contemplated by any of the projects now proposed this plan assumed substitution of ideal monthly distibution of the irrigation water in place of the natural flow diversion for vested rights, as in the first plan. The 75,000 acre feet of capacity was found capable of supporting the ideal annual draft of similar quantity with reasonable dependability. Large deficiencies occurred in several years, but shortages in excess of 10 per cent developed in only 5 of the 30 years. These would have to be made up by increased pumping from underground supplies, and by restricted use, since study of the severe drought periods indicates that provision of large carry-over storage to eliminate the deficiencies would involve exorbitant cost and great waste of water through evaporation.

Claims Waste Negligible

In the second plan the surplus flow would be regulated for spreading with but little waste. The average quantity spread for percolation would amount to 55,000 acre feet annually, and the total volume over the 30-year period discharged at rates in excess of 1,000 acre feet would be only about 40,000 acre feet, or approximately 1,300 acre feet per year. It may be noted that in the latter plan, 50,000 acre feet of capacity is reserved for flood control which would be used hardly at all.

From direct hydrographic studies, and all other evidence presented, it seems reasonable to conclude that storage capacity beyond 200,000 acre feet, whether built jointly by Pasadena and the Flood Control District, or separately, is not justified.

Some argument has been offered that excess capacity is desirable in order to provide against depletion through accumulation of silt and detrital material in the reservoir. Unquestionably, the storage space will be progressively diminished in such manner, and unfortunately there exists no definite data on which a dependable forecast of the depletion may be based. Estimates by various engineers, based on experience with other large reservoirs and river measurements, range from 200 to 700 acre feet as the probable annual sedimentation to be expected. The mean of these estimates may not be far off, but in any event it appears that the debris accumulation will not sufficiently diminish the reservoir capacity so as to create a very serious problem within the next 50 years. Endeavors to provide at present for taking care of this problem beyond 50 years are obviously beyond economic bounds.

Table Gives 10-Year Record

The City of Pasadena has made a comprehensive showing of the serious situation existing in regard to its water requirements. The present supply is obtained partly by direct diversion from the small streams to the north of the city and the rest by pumping from the small Monk Hill and Raymond basins underlying the city. The production and distribution of water is conducted as a municipal enterprise which serves not only Pasadena, but sections of some of the adjacent towns. The accompanying table presents a record for the past ten year period. As may be noted, the annual increase in consumption has averaged about 7.5 per cent annually over the period, even though at the latter end of the period severe restrictions on water use in the face of a shortage served to reduce the normal consumption.

The withdrawals from the San Gabriel River Basin by Pasadena comprise only about 40 per cent of the total draft of the basins and during the past few years the ground water plane has been receding at such serious rate that substantial expenditures have been required for the deepening of wells and the installation of pumping machinery of greater capacity. In the report of S. B. Morris (Pasadena Ex. No. 1) a comprehensive endeavor has been made to picture present conditions and to forecast conditions which may be anticipated in the immediate future. Mr. Morris concludes that with normal precipitation in the next five years, and a rate of increasing draft equivalent to that of the past five year period, the water plane will have receded nearly 150 feet below the present low levels. It is obvious that great expense would be involved in deepening the wells and substituting new pumping machinery to successfully follow the receding water. It is equally obvious that Pasadena has outgrown the present source of supply and is adequately justified in seeking to provide a new source in the shortest possible time.

Future Requirements Forecast

An effort has been made to forecast the future requirements of the city and the result is presented in the accompanying illustration. The unit consumption, including distribution loss, has been assumed at 150 gallons per capita which corresponds closely to consumption in 1923-24. The population has been projected on the basis of the forecast developed for the Los Angeles metropolitan district in connection with the writer's previous investigations (Report-Project No. 105) for the Federal Power Commission. This forecast indicates that the water requirements of Pasadena, exclusive of the outside territory served, will reach 13 M.G.D. by 1930 and 21 M.G.D. by 1940. The latter amounts to about 24,000 acre feet per year which, is nearly equivalent to the average annual yield for domestic purposes from

the operation of the proposed reservoir on the San Gabriel River.

After the San Gabriel supply is available, Pasadena would presumably use the existing pump installations for standby purposes and to carry the load when the San Gabriel supply is deficient. Such operation will permit storage in the underground basins to build up and be maintained somewhere close to present levels if the draft made from the basin by other interests may be restricted to prevent withdrawals.

It is generally conceded that by 1940, or 1945 at the latest, the City of Los Angeles and the entire surrounding metropolitan district, including practically all of the habitable parts of the county south of the mountains, will have reached the limit of the water supplies available for domestic use. Included in the available supplies contemplated for development in this period is the expansion of the aqueduct system so as to utilize not only the entire Owens Valley yield but also that which may be diverted from the Mono Lake basin. To meet the increased demand created by growth following 1940 there seems no alternative but the Colorado River, and therefore, the completion of the great aqueduct proposed from that source will likely be realized within the next 15 or 20 years. The project will be so vast, involving an outlay of between $150,000,000 and $200,000,000, that it will doubtless be shared by the entire metropolitan district including not only Pasadena but the whole San Gabriel territory. Under such circumstances it would appear that insofar as Pasadena is concerned the San Gabriel project will satisfy requirements until the Colorado River water is likely to become available.

Long Beach Proposes Bonds

An election as soon as possible to pass on a bond issue of approximately $2,500,000 for the water department of Long Beach is advocated by Water Department Superintendent Clark H. Shaw. Items in the proposed issue are $500,000 for a reservoir with a capacity of 50,000,000 gallons; $578,000 for sixteen new wells, including four at North Long Beach, and additional pumping equipment for the North Long Beach Citizens Development and Alamitos stations; $1,150,000 for pipe, and $150,000 for miscellaneous purposes. One of the most urgent needs is purchase of pipe which must be installed in streets waiting to be paved. A number of paving projects are being held up until the city can furnish pipe to install in advance of the paving.

Acetylene Torch Cuts Way Through 36-inch Water Line in Quick Time

Service Operator Prevents Delay in Installing an Emergency Pipe System

THE water works superintendent of an Ohio city was recently confronted with the problem of providing an emergency relief system in the pumping station. Formerly only one system had been available, and should a major accident occur, the entire city would have been without water supply. Among other changes necessary to correct this situation, it was decided to replace a worn gate valve in an old cast iron line and to lay several hundred feet of new 36-in. cast iron pipe.

It was imperative that the removal of the old valve and the insertion of the new one be made in the shortest possible time, since to do the work it was necessary to shut down the pumps. Such a condition would be serious in case of fire. The manager had heard that cast iron could be cut rapidly with the oxy-acetylene blowpipe and realized that this offered a possible solution of their problem of maximum speed.

A consultation was held by those in charge and the decision reached to use the acetylene torch.

However, the department did not have any welding and cutting equipment, nor did any of the workmen know how to operate it. Since the estimated cost of this one job was $300, it seemed an opportune time to buy a cutting blowpipe and start using it. The apparatus manufacturer was willing to guarantee that the cutting could be done with speed, and the offer of service was accepted at once.

It was decided to do the work at night, when the flow of water was lowest. The service operator reported on a Saturday evening and started to cut the pipe at 10 o'clock. He finished in an hour and twenty minutes; and the new valve was inserted and pressure turned on again in less than three hours.

The conditions under which he had to work were far from ideal. The pipe was close against a wall under a balcony, and such close quarters made it very difficult to manipulate the blowpipe properly. In addition, the valve that shut off the water in the line leaked badly and since the line could not be drained completely, there was about 6 in. of water in the bottom of the pipe. Notwithstanding these handicaps the demonstration convinced the superintendent and his associates and they immediately started planning applications of cutting and welding in their daily routine work.

While preparations for removing this valve were being made, the work of laying the new 36-in. cast iron line had gone forward. Each joint had been imbedded in concrete to about one-third the depth of the pipe to prevent settling and leaking at the lead-caulked bell and spigot joints.

The line was to carry a working pressure of 150 lb. per sq. in. Each section of pipe was supposed to have been tested to twice that pressure at the foundry but when water was turned into the line one of the sections was found full of sand holes. There was nothing else to do but replace the section. Located some distance from the end of the line, it would have been necessary to remove three lengths and a tee in order to replace it.

How the Pipe Was Cut

This bad section was discovered while the service operator was still at the water works. Naturally he volunteered to help remove it and at the same time give the water company's operator further instruction in cast iron cutting. Fortunately the blowholes were all near one end of the pipe. This simplified matters considerably. First, the pipe was cut in two in the middle. Again it was impossible to drain the pipe entirely. Therefore the cut was started on the under side, for two reasons: first, it let the water out of the pipe; and second, if the top had been cut first, the slag would piled up on the bottom of the pipe, thus adding to the natural difficulties of cutting overhead through a pipe wall 1⅞ in. thick.

The service operator made the first cut, the customer's operator observing closely. The latter then took the blowpipe and made a second cut about 18 in. away. This 18-in. section was then lifted out with a chain hoist. While these cuts were being made (which took about 1 hour, 10 minutes), another operator was melting the lead caulking out of the joint, using a welding blowpipe with a large head. The bad piece of pipe was then backed out of the bell and lifted from the trench.

To complete the repair a sleeve was slipped over the good section of the pipe remaining in position, a new piece of pipe, cut 4 in. shorter than the one removed, was then inserted and caulked. Finally the 4-in. gap was closed by slipping the sleeve over it and bolting and caulking it into position.

The whole operation required less than a day and a half.

Equitable Charges for Automatic Sprinkler Connections

By MAJOR W. CARTWRIGHT

THIS is not the first time the question of charges for connection to automatic sprinklers from public mains has been discussed in the meetings of the American Water Works Association, but so far as I know it is the first time that an insurance organization like the Board of Fire Underwriters of the Pacific has been privileged to offer you its views on this important subject.

It is generally recognized that a public water system has but two major functions, namely;

(a) To supply water for domestic and industrial purposes, and
(b) To supply water for the extinguishing of fire.

I believe it must also be accepted that if a water system is to meet fully all its obligations it must be capable of supplying both these demands.

I think that speakers on this subject have not always recognized the automatic sprinkler system as coming within the latter class, and some rate schedules, even, make no distinction between connections to serve automatic sprinklers and connections to serve ordinary domestic purposes.

The relation of automatic sprinkler systems to the water system largely hinges on its manner of operation. Unlike most other fire extinguishers it is set in motion by the fire itself and without the aid of any human agency, and it usually happens that the fire is extinguished at its very inception by the opening of one or two heads, and to the accompaniment of a very audible water flow alarm. This almost invariably means that very little water is used in extinguishing the fire, and the water flow alarm insures the water being turned off the system at the control valve as soon as the fire is out.

On the other hand it is safe to say that in the absence of a sprinkler system the fire would not be discovered until well under way, and in the unavoidable delay of getting the fire department apparatus at work it will have reached much more serious proportions. Very often enormous quantities of water are necessary to extinquish the fire, all of which is furnished free of charge.

Give Lower Insurance Rate

It is sometimes held that "Readiness-to-Serve" justifies a high annual charge for a sprinkler connection, or that such a charge is proper on the grounds that it confers on the user the advantage of lower insurance rates. Every property owner is entitled to fire protection from the public mains without cost other than his ordinary contribution to the general tax levy. In the case of private water companies a part of this tax is passed on to them, and in return the water company, whether privately or publicly owned, provides water for fire extinguishment, and street mains of adequate size for the fire demand. The "Ready-to-Serve" feature exists already in the obligation of the water utility to provide water for general fire purposes, and if a property owner provides, at his own expense, a way of taking the water to which he is already entitled and applying it to the fire through a more efficient and economical means than street hydrants provide, he has contributed no additional burden or expense to the water company, but has on the other hand considerably lessened it.

Neither should the value or benefit to the user be the measure of the charge he should bear. Indeed this argument introduces an entirely new principle which if consistently applied would necessitate schedules based upon the uses all consumers made of the water and the profits they derived from it. It would be improper to deny that the normal condition of any building is one in which all fire hazards are properly cared for, and for which a relatively low insurance rate is, quite properly, charged. An unsprinklered building is a risk in which the owner has neglected to avail himself of the fullest degree of fire protection, and for this abnormal condition he is penalized by being called upon to pay a larger insurance premium than he otherwise would.

Conditions Alter Savings Effected

It is not always the case, however, that the property owner would, by installing automatic sprinklers, save enough to enable him to pay a large annual charge for the water connection in addition to interest on his investment and an installment to wipe out the capital cost. Indeed sprinkler protection appears to have been developed to the point where most of the plants which show a large insurance saving are already sprinklered. There is, too, a large class where the saving will never pay for the cost of protection, but in between these two there is a very large number of risks where the saving which might accrue is entirely swallowed up by the waterworks charges, or the residue is so small as to be unattractive to the owner. Risks of this class constitute the large majority of commercial buildings and from a fire loss point of view they contain the most potential hazard both as individual fires and as conflagration starting points.

If then it is conceded that every property owner is entitled to water for fire extinguishment without direct payment for the same, the need for a meter in the water connection is not apparent, and can be justified only as a means of detecting a surreptitious use of water for other purposes than the legitimate and special function for which it is furnished. If this theft of water is taking place it is criminal, and as such is a matter for the police department, and not the water company, to take care of. The remedy does not lie in imposing a general and prohibitive requirement upon every owner of sprinklered property, be he guilty or innocent. Mr. George W. Booth, Chief Engineer of the National Board of Fire Underwriters, has stated :

"It is our opinion that sprinkler system services, through which no water is drawn except for use in connection with fire protection, should not be metered: There is normally no draft through them, and we believe that it is possibe to prevent the illicit use of water by other and simpler means than the installation of meters. These devices add to the expense and likewise to the friction loss in the supply line; some types of meters also introduce the probability of clogging or entirely cutting off the supply by foreign material which may be in the pipe"

A weighted check valve with a smaller meter in a by-pass, in conjunction with the water flow alarm system of the sprinkler installation, would offer sufficient safeguard against the possibility of water stealing. Frequent inspection of all sprinkler systems is made by insurance organizations and these could, if necessary, be supplemented by independent inspection by the water company at the expense of the property owner. This system has been adopted in some cities and is apparently giving satisfaction.

Minimize Economic Losses

Apart from the loss an individual property owner may suffer from a fire, I think there is another and larger aspect of the case we should consider. A fire is a large irrevocable loss to the whole community. Our own insurance premiums will have to be kept high enough to enable the insurance companies to reimburse the owner, and the municipal and State taxes which he formerly paid will have to be made up by the rest of us. A destructive fire will cause large plants to close down or perhaps go out of business and leave their employees without means of livelihood. The owner of sprinklered property has materially decreased the likelihood of such a catastrophe. Labor will benefit by its greater assurance of continuous employment. The danger to human life will be diminished. Fire departments will be relieved of a large portion of their arduous work, and less de-

A paper read before the California Section of the American Water Works Association at their Annual Convention at San Diego, on October 28, 1926.

mand will be made on the public utility providing water. He ceases to be a serious fire exposure to the surrounding property, for it is a fact that a conflagration never started in a sprinklered building; and he has set up a fire break or conflagration barrier in the event a fire has started elsewhere in the neighborhood. New York is considered by experts a city immune from conflagrations on account of the barriers set up by sprinklered buildings.

I mention these incalcuable public benefits to be derived from sprinkler protection because I believe that this status of the automatic sprinkler is a most important factor and justifies its recognition as in a class entirely distinct from industrial or domestic uses of water.

The recent publication by the National Board of Fire Underwriters of the fire losses in America for 1925 brings me to the last point on which I will ask you to hear me. Over 570 million dollars of property and thousands of lives were sacrificed to fire. It is to be expected in the natural course of events that there should be an increase in our fire losses. New processes in the manufacture and handling of the goods which serve the changing needs of our civilization have increased enormously the fire hazards attending them. Gasoline for instance was, only a few years ago, a by product in the manufacture of kerosene but is now in general use for many industrial purposes, and has increased the fire waste tremendously.

Fire Chiefs' Resolutions

If we conscientiously strive to prevent these increasing hazards from making further additions to the annual fire waste, we must make it a matter of public duty to help in discouraging any condition which tends to destroy the interest of the property owner in equipping his building for the reduction of the fire peril.

The Pacific Coast Association of Fire Chiefs at its annual meeting last year expressed it feeling on this subject by passing the following resolution:

"WHEREAS This Association is of opinion that automatic sprinklers are a public benefit in that they have proved to be an efficient means of fire extinguishment and in that they tend to conserve human life, wealth and property from disastrous fire, and

WHEREAS, it is believed that an automatic sprinkler system does not increase the demand on the public utility providing water, but instead tends to decrease it

IT IS THE DESIRE of this Association to encourage the installation of automatic sprinklers, and to discourage high monthly charges for connection from public mains to automatic sprinkler systems, provided the individual or individuals receiving this service assume the entire cost of the installation and maintenance of the connection."

High charges for sprinkler connections are a serious deterrent to the enterprise of property owners in making proper provision for the safety of their premises, and our attitude to this question will largely be the measure of our conception of the ideals of good citizenship.

Society of Engineers

The Society of Engineers of the San Francisco Bay District held their regular monthly meeting in the Blue Room of the Palace Hotel, San Francisco, on Tuesday evening, January 11th, and the following members were elected officers of the Society for the ensuing year.

George E. Tonney, president.
John Wallace, vice president.
W. G. Rawles, treasurer.
Albert J. Capron, secretary.

The board of direction consists of five members of the Society as follows:

H. H. Ferrebee, Geo. H. Geisler, Louis F. Leurey, R. C. Briggs, and R. G. Green.

The officers of the past year were: Glen B. Ashcroft, president; Geo. F. Tonney, vice president; Geo. H. Geisler, treasurer; Albert J. Capron, secretary; while the board of direction consisted of Louis F. Leurey, past president; Wm. H. Phelps, C. T. Wiskocil, R. C. Briggs and R. G. Green.

"Poor Pressure" Complaints Due to Plumbing Changes

By V. E. PERRY

*Assistant Manager of Sales, Spring Valley Water Company**

Until about 1890 the Spring Valley Water Company used as a standard for house services a ½-inch drive tap with a ½-inch lead service pipe, and from 1890 to 1908 used ⅝-inch driven taps and ⅝-inch service taps. In 1908 they adopted as standard for residential and small commercial services a ¾-inch screw tap with a ¾-inch galvanized pipe service.

These changes were brought about by an increasing per capita water consumption due to a change in the public plumbing conditions as shown in the following table of population and water consumption:

Period	Population U. S. Census	Consumption Total Gal.	Consumption Per Capita Gallons
1880	234,000	12,648,000	54
1890	300,000	20,416,000	68
1900	343,000	25,644,000	74.2
1910	416,900	35,604,800	85.4
1920	508,400	36,167,700	71.1

Meters Cut Consumption

In 1918 the entire city was metered, which accounts for the decrease in the water consumption as shown in the above table. There being a decrease of 16.7 per cent, or about 1-6 in the per capita consumption for the decade 1910 to 1920, due to metering.

With the installation of automatic toilets, shower baths and instantaneous heaters, the standard size service had to be increased as did the house plumbing. I might hazard the forecast that the time is not far distant when we shall again have to increase our standard services in order to provide for the more modern plumbing such as flush valve toilets, side spray showers, etc., which are now generally used and which require oversize services and house pipes.

These changes in the plumbing conditions have brought about a number of complaints of "poor pressure," by consumers who, having installed too small a house pipe, could not get sufficient water for the operation of such fixtures as shower baths, instantaneous heaters, etc., and asked the water company to investigate the situation.

In all cases where the size of the service was less than the present standard ¾-inch, we have increased it, with the understanding that, if this did not remedy the situation, the consumer would increase the size of his house piping. The wisdom of increasing services in advance of the house piping is apparent, for it changes the responsibility of good service from the company to the consumer.

Relations With Plumbers

Our dealings with the plumbing fraternity in general have always been pleasant, but occasionally one of the smaller members of the craft will cause the water company considerable annoyance by his lack of knowledge of some of the common factors in hydraulics, such as frictional loss being called "poor pressure," and instructing his client that it is "up to the water company to increase the pressure," usually a physical impossibility. When the water company is called upon to remedy these conditions our investigation invariably develops that the cause is due to the small size of the house pipes, or the service pipe, or both.

There were 65 cases reported on during May, June, and July of 1925. Of these there were 48 cases where the services were the same size or smaller than the house pipe and 17 or 26 per cent cases, where the house pipe was less than the service pipe. Of the 48 cases where the service pipe was the same size or smaller, 12 of them, or 27 per cent were for ½-inch service with ½-inch house pipes. In round figures about 45 per cent of the complaints are due to too small house piping.

In conclusion, we believe that a little more co-operation between the plumbers and the water company would greatly reduce the number of complaints of "poor pressure" and speaking for our company, we will heartily approve any act that will bring about this co-operation.

*Extracts from a paper presented before the A.W.W.A.

STORAGE & DISTRIBUTION

Description of the Impounding Works of the San Diego Water System

By R. C. WUESTE

Supervisor, San Diego Municipal Impounding System

EVEN the most casual consideration of the climate, topography, and geology of San Diego County discloses that the sources of available water supply for the City of San Diego within a fifty-mile radius are very limited. In this sector, there are no perennial streams or natural lakes. Ground water in any quantity is pretty generally confined to the narrow ribbons of water-bearing drift forming the valley floors of the main drainage channels which score the county from the crest of the Coast Range on the east to the ocean shore-line on the west.

Although San Diego is not limited to seek water within fifty miles of her population center, it is nevertheleess a fact that other sources of worth-while proportions are only to be reached by going four times that distance.

Confronted by these conditions and limitations, the one logical process of developing a dependable supply within the county has been adopted. This implies the construction of dams at favorable basin mouths, in which the locality fortunately abounds, for the impoundment, retention and storage of the winter runoff resulting from the impressment of the rainy season storm clouds upon the inclined plane of the county watershed area. The County of San Diego is a noteworthy example of the application of the principal of artificial lake creation to transmute an erratic surface source of supply resulting from the vagaries of scant seasonal rainfall, into dependable and regulated gravity duty. The first applications of this principle of development date back forty years and had their origin in the forced realization of the futility of any other means of producing adequate supplies.

Population Growth

Rapid population growth of the Pacific Coast communities has furnished many surprises. The case of Los Angeles has been nothing short of phenomenal. In a twenty-year period from the time she was San Diego's present size of 150,000, her population increased to three-quarter million inhabitants, an average population increment of 30,000 per annum. San Diego's present sustained growth is about one-half this rate, with good reason to believe that it will soon approach a rate equal to that of Los Angeles. County, or regional population increase is noted to continue parallel with the city's growth, so that it is evident that local water developments must follow one another in rapid succession.

The runoff producing area of San Diego County comprises a thirty to forty-mile wide belt of mountainous territory mainly of granitic composition, defined on the east by the divide overlooking the Imperial Valley and on the west by the line of nearest-the-coast dam and reservoir sites. The area east of this divide is arid and almost rainless except for summer thunder storms. It drains to the east away from San Diego, falling away very abruptly from elevations between 4,000 and 6,000 feet to elevations below sea level in Salton Sink. This line of demarcation between the area of highest county rainfall of forty inches and the area of almost no rainfall is astonishingly distinct. Rainfall west of this line of damsites is ten inches or less.

Financial Limitations

The county watershed area is about 2,000 square miles. Areas lying north of the county boundary line in the Santa Margarita Basin and south of the international boundary line in the Tia Juana Basin which may be considered tributary to San Diego, brings the total to 3,585 square miles. The most reliable estimates show that this area when fully developed, will yield a little less than 200 m. g. d., considering surface water, only. Ground water sources are regarded as emergency supplies and if used as such, can be shown to materially increase the safe net yield limit just quoted.

At present San Diego County's water supply is about one-fifth developed from the storage and correlative safe net yield viewpoints. The chief reason why the runoff producing area in the county is not fully developed today is that of cost. Although in other sections of the United States, water development can be and is made in advance of population,—here, on account of its high cost, such development must wait upon the influx of people and money. However, the rapidly increasing preciousness and demand for water will compel complete development within twenty years.

To carry these general statements just a little farther, the local quantitative relationship between population and safe net yield of water supply, is that 10,000 people require one m. g. d. of safe net yield at 100 gallons per capita per day, including all municipal uses.

Monetarily, San Diego's assessed valuation of property has corresponded very closely to her population curve with a ratio of about $1,200 per capita. Only fifteen per cent of this is available for bonding for all purposes. When it is realized that the capitalization by means of bond issues of the city's present supply works of reservoirs, dams, transmission, distribution works and appurtenances averages one million dollars per m. g. d. of safe net yield, the intricacies and limitations of the local problem, other than physical, tax the utmost ingenuity of the hydraulic engineer.

Description of City's Works

Very briefly, San Diego's water supply problem began of course with the first settlements here. During the rainy season the arroyos and ravines held living water. The rainy season over, the creek bottoms furnished ground water for the nuclear community and pioneer agriculturists. The padres who founded the San Diego Mission in the late 18th century at the upper end of Mission Valley developed a diversion gravity supply for the needs of the Mission, the boldest attempt for a hundred years to produce a water supply independent of the vagaries of rainfall. With the settlement, in 1867, of "New Town," where San Diego's business section stands today, and the hectic boom of 1886-7, well supplies within the city limits were quickly seen to be inadequate. The pioneer storage developments on the San Diego and Sweetwater Rivers followed. Conception of similar developments all over the county date back to this period. The collapse of the boom, the drouth of the late nineties ending in 1904, the community's struggle for existence, the reversion to the Mission Valley sands for a city water supply, the far-sightedness and resources of the late Mr. Spreckels in developing the Cottonwood-

A paper read before the seventh annual convention California Section, American Water Works Association, San Diego, Calif.

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Dams and Reservoirs

NAME	TYPE	HEIGHT ABOVE STREAMBED (Feet)	YEAR BUILT	COST (Dollars)	RESERVOIR CAPACITY M. G.	SAFE NET YIELD (m.g.d.)
Morena	Loose Rock Fill	166	1912	1,400,000	17,492.8	4.0
Barrett	Concrete Gravity Arch	179	1922	1,650,000	15,512.2	4.4
Upper Otay	Concrete Arch	80	1901	80,000	835.7	0.5
Lower Otay	Concrete Gravity Arch	149	1919	745,000	18,979.5	3.3
Chollas	Earth Fill	46	1906	70,000	90.7	. .
Hodges	Concrete Multiple Arch	130	1918	500,000	12,284.3	4.3
San Dieguito	Concrete Multiple Arch	51	1918	50,000	368.6	. .

Otay supply, the city's gradual awakening from lethargy and its final irresistible momentum and accelerated growth, justifying and making necessary all the later developments—form colorful and romantic epochs in local water development history.

At the present time we find partial development of the San Luis Rey, San Dieguito, San Diego River, Sweetwater, Cottonwood and Otay drainage areas, presenting dams and accessory structures of a variety of types. The city at the present time owns and controls the dams and reservoirs on the San Dieguito, Cottonwood and Otay drainage basins and accessory structures, serving same.

With due respect for the admirable work of local pioneer engineers and promoters, some of their efforts indicate errors in judgment, due probably mainly to lack of reliable data on runoff. The productivity of watersheds and the resultant safe net yield of developments were in instances greatly overestimated. It is not to be wondered at that certain developments have been put in with little regard to adhering to a logical schedule of sequence. Today, the wealth of engineering reports on the local water supply problem and the cumulative record of performance of watersheds and reservoirs makes possible a fairly accurate analysis of the local situation.

It was not until very recently, however, that a plan of development by the city was formulated by City Manager F. A. Rhodes, detailing step by step the proposed development for the next twenty years which will keep the safe net yield available to the city ahead of the expectancy curve of population. This strategical denouement of the latent re-

(Continued on Page 44)

ACCESSORY STRUCTURES

NAME	TYPE	DESCRIPTION	YEAR COMPLETED	COST (DOLLARS)	CAPACITY (M.G.D.)
Dulzura Conduit Extension	Concrete lined canal	0.29 miles Trapezoidal ditch box syphons, metal flumes, concrete drops	1915	185,000	40.0
Dulzura Conduit	Concrete lined canal	11.0 miles Trapezoidal ditch, wood flume and tunnel, grade 0.08%. Bottom unlined	1909	521,000	40.0
Lower Otay Filtration Plant	Rapid Pressure	24—8x20 Horizontal Units	1915	125,000	12.0
Otay San Diego Pipe Line	Continuous Woodstave and Cast Iron	19.15 Miles compound line 40 in., 36 in., 34 in., 32 in., 30 in., 24 in.	1906	529,000	7.8
Bonita Pipe Line	Riveted Steel	8.08 Miles 28 in. No. 0 Riveted Steel	1915	220,000	6.8
Chollas Booster Pump	Electric Centrifugal	Double Suction 2 Stage 250 H. P. Motor	1914	15,000	12.0
Mission Valley Pumping Plant	Electric Centrifugal	12—4 in., 4 Stage Vertical 10 H. P. and 2 10 in., 4 Stage 250 H. P.	1914	100,000	5.0
Hodges Conduit	Concrete lined canal	4.65 Miles Trapezoidal ditch, circular reinforced concrete syphons, metal flumes	1918	200,000	9.7
Lockwood Mesa Gravity Line	Reinforced Concrete Pipe	6.72 Miles 24 in., 26 in., 27 in. reinforced circular concrete pipe	1918	108,209	3.9
Lockwood Mesa Reservoir	Open Concrete lined	Trapezoidal Concrete Lined basin, 60x100 bottom, 84x124 top, 8 ft. deep (M.G.)	1918	10,000	0.5
Del Mar-La Jolla Pipeline	Machine banded wood-stave and reinforced concrete	10.55 Miles 16 in. and 18 in. diameter	1920	200,000	3.5
Torrey Pines Reservoir	Open Concrete lined	Square Trapezoidal Concrete lined basin 200x200 bottom, 230x230 top, 10 ft. deep (M.G.)	1920	25,000	3.0
Torrey Pines Filtration Plant	Rapid Pressure	7—8x20 Horizontal Units	1926	40,000	3.5
Torrey Pines Booster Pump	Electric Centrifugal	3 6 in., 2-stage pumps; 3—125 H. P. Motors	1926	8,000	4.5

NOTE: The above list does not include the distributing system within the city, or its accessory standpipes, service reservoirs, filter plants and booster pumps.

For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

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METERS & METERING

San Francisco Street Contractors Assume Liability for Meter Installations

THE Spring Valley Water Company of San Francisco, California, has some rather novel methods of handling their meter problems. It is common practice among a great many larger cities to allow the various contractors doing street work a flat rate for the water used while on such work. San Francisco found that this method led to a great amount of wastage, which it took steps to eliminate.

When a contractor applies for a permit to use water while on street construction work of any kind, the city usually installs a meter on one of the nearby hydrants. The contractor pays the net cost of such an installation and he gains an advantage in the rates charged. This is usually better than a flat rate, because any flat rate is made large enough to cover wastage and the cost of special inspection expense. When such an installation is made, the contractor is made responsible for the meter, and if damaged or lost, the contractor foots the bill.

How Meters Are Read

San Francisco has 3500 meters installed in the basement areas under sidewalks in the downtown district, and over 71,500 placed in the open, along the curbline of the sidewalks. All of these meters are read once a month, and the entire city is covered by thirteen meter readers in twenty-one working days. It is common to read from 100 to 150 basement meters per day, and from 200 to 250 meters per day in the less congested districts. The number of meters read per day depends a great deal upon local conditions, and it is not uncommon for some of the readers to read as high as 700 meters per day, where locations of meter boxes are readily accessible, and no delay is encountered. The average throughout the month is about 300 meters per day per man for the twenty-one days.

On the remaining five days of the month, the men clean dials, and work up reports of broken boxes, and on the last day, they take the municipal and corporation readings.

The readers use a cloth bound book, the pages of which are 4½x7 inches, to make all entries of the day. At night these books are turned over to the head bookkeeper who re-enters these entries on the schedule sheet. They are then sent to the billing department for invoicing.

The Current Meter Problem

In reviewing the publications on current meters as they appear periodically in professional journals, it is quite evident that the instruments subjected to trials enjoy a peculiar status. Contrary to the regular order of things, in which tools are made to fit the work, here the work is fitted to the tool.

Tests of such instruments are conducted for the purpose of studying the results when meters are exposed to water conditions similar to those that are known to exist in open streams. It has long been realized that calibrations of current meters at rating stations can not supply rating equations which will meet all field conditions, and because of this correcting factors are sought.

Testing of meters is educational and should be encouraged, but to experiment for the purpose of developing adequate correcting factors to be applied to current meter work, seems to be a mistake.

Characteristics of flowing water in open channels can not be imitated artificially, owing to the ever-changing stream directions and eddies. Supposing one should have succeeded, there would be another task to apply the correcting factors properly. The attempt would resolve in guessing and approximating.

Skillful hydrographers have acquired, through practice and by observation, a sense or talent of getting the best out of current meters.

Current meters are mechanical devices, made to gauge stream velocities by meter rotations. To accomplish this accurately it is essential that the position of the rotor axis be in a definite relation to direction of stream flow.

This latter stipulation contains all that makes a 100 per cent accurate current meter impossible; it reduces the status of current meters considerably.

Notwithstanding this fact, current meters are used by the engineering profession and it would seem only reasonable to make every effort to develop meters to meet the characteristics of flowing waters, rather than to assume that water flows in parallel stream lines and arrange for difference-corrections.

Meter calibrations are only possible where essential conditions, such as meter position and stream direction, are definite and known. Meter work is done where the essential conditions are unknown; hence it becomes the duty of the meter to compromise the differences of water conditions between rating stations and open streams.

European engineers and scientists, who have a priority in current meters, have decided in favor of the horizontal axis meter type, claiming higher efficiencies for their meters.

It is evident, and is substantiated by tests, that a vertical axis meter disregards stream direction, and for that reason is not capable of compromising the differences of stream conditions.

The successful meter will have to be equipped with a rotor free exposed to the current, of light material, to be under complete control of stream forces. It must be so formed as to respond in its rotation to the component of the forward stream forces only, in order to qualify for the method of vertical integration, the most economic manner of stream gauging. The body of the meter must be small and stream-line, to avoid or minimize disturbance of the original stream flow. The arrangement of the various meter parts must be such that the meter will automatically assume a normal and quiet position when exposed to stream flow favorable for meter work.

The meter as outlined above has been developed by the U. S. Bureau of Public Roads, Division of Agricultural Engineering, after extensive and detailed studies of the current meter problem. Laboratory and field tests prove it to offer simplification and other decided advantages to stream gauging.

Will Sell Three Water Systems

The Bisbee-Naco Water Company has been authorized by the Arizona State Corporation Commission to sell its public water utilities in Bisbee, Lowell and Warren to the People's Arizona Gas and Electric Company, under a sales contract with the W. B. Foshay Company of Minnesota. Purchase price was set at $450,000. This is to be covered by an issue by the purchaser of 3000 shares of capital stock at $100, and of $500,000 of 5½ per cent bonds.

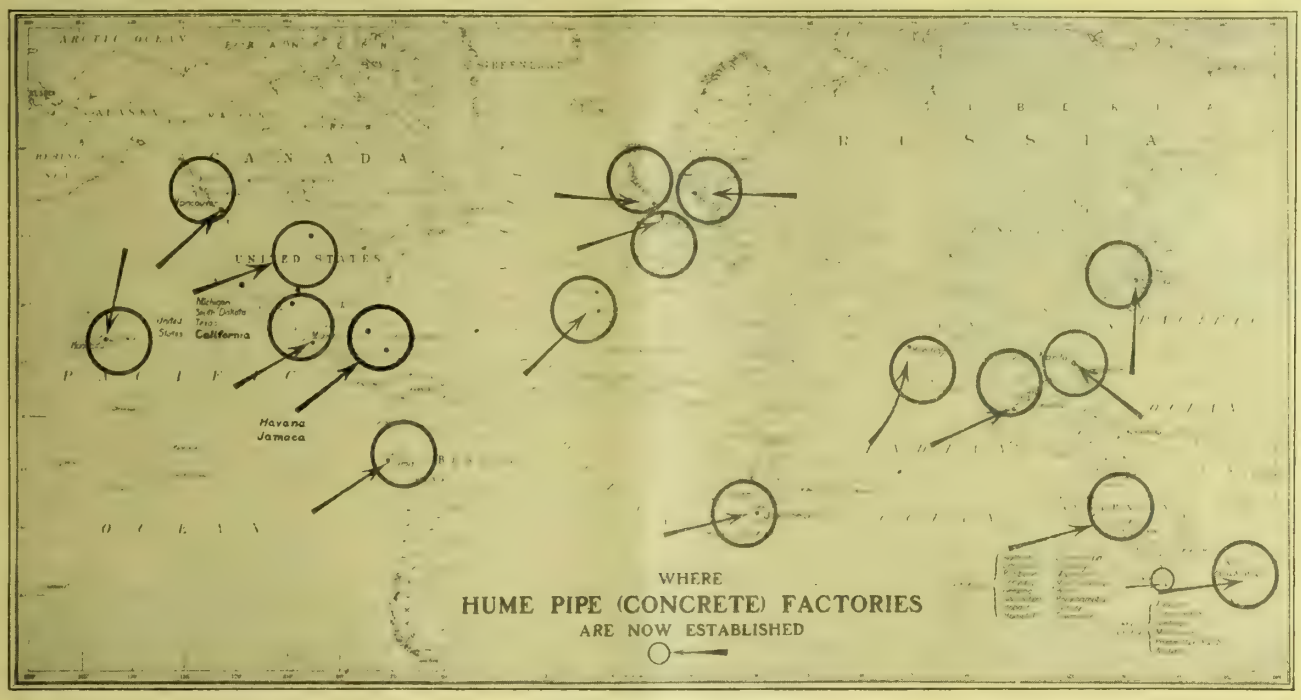

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Fig. 200

Fig. 180

Fig. 40

Fig. 41

BRASS MATERIALS FOR WATER AND GAS

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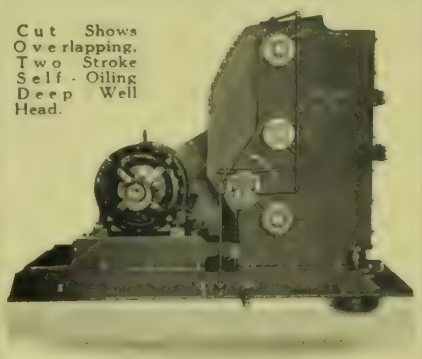

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Stevenson Creek Test Dam Withstands Flood Waters

(*Continued from Page 15*)

been measured with consistent results in successive tests. The maximum movement was about .001 inch. A spreading of the walls of the canyon due evidently to the arch thrust of the dam has been measured. At the 18-foot level and 33-foot level this spreading amounted to about .03 inch.

First Filled September 1926

When the reservoir was filled to the 60 foot level for the first time, on September 18, the time schedule did not permit the attendance of fund contributors who were not in California; nevertheless several members of the committee, a number of representatives of contributors, and a few guests were present, besides the testing staff—about thirty all told.

The party arrived at noon, at which time there was about 50 feet of water behind the dam and the water level was rising slowly. Full depth was attained about four o'clock in the afternoon, and the water was allowed to just overflow the crest. With the water surface maintained at this level the measurements were begun at 11 p. m. and completed at 1 a. m. of September 19. The reservoir was then emptied and the "no-load" measurements were made between 2:20 and 4:15 a.m., on the 19th. Many of the guests witnessed the midnight measurements, and all were enthusiastic about the conditions for the tests.

On September 21 and 22, another load test was made with the water at the 60 foot level. On September 22 and 23, observations were made with the water surface successively at the 60, 50, 40, and 30-foot levels. This, the 13th load test, completed the program of field observations.

Under a head of 30 feet of water, a horizontal crack appeared approximately on the center line, between the bottom of the dam and the foundation on the upstream side. The successive opening of this crack was measured by an electrical resistance instrument. An opening of as much as .04 inch has since been found.

Very Few Surface Cracks

No crack within the dam proper occurred with a depth of water less than 50 feet. Under that head a crack occurred on the vertical center line, extending entirely through the dam from the downstream face to the upstream face, and down to an elevation of about 49 feet on the downstream face. On the upstream face it did not extend down so far. Later tests showed that either raising the water level or lowering it from about 50 feet caused a partial closing of the crack. This crack has since extended downward to an elevation of about 41 feet. With the reservoir empty the crack generally closes to such an extent that it is not easily found.

Under a head of 60 feet of water another crack appeared on the vertical center line of the dam extending from two inches above foundation rock to a height of about 9 feet. This crack has since extended to a height of about 13 feet.

The presence of each crack was first discovered by means of telemeter readings. In the latter instance the measured stress just prior to the formation of the crack was about 570 pounds per square inch. This agrees fairly well with the tensile strength to be expected from concrete of the grade used. The measured stress just prior to the formation of the crack at the top of the dam was about 300 pounds per square inch. It is possible or even probable that vibratory stresses of considerable magnitude, due to partial opening of the 24-inch discharge valve in the dam made the total stress considerably greater than 300 pounds per square inch. It is possible also that shrinkage or temperature stresses not included in the telemeter readings were present.

The stresses given in the preceding paragraph are based upon a modulus of elasticity of the concrete of 4,000,000 pounds per square inch, though recent tests of the beam used for this purpose indicate an increase of the modulus over this value.

Leakage Is Negligible

In testing there has been extremely little leakage. For holding the forms together during construction, form bolts extended entirely through the dam from the upstream to downstream face. Around the downstream ends of about one-quarter of these bolts there appeared moist spots when the dam was under a head of water, due evidently to a little water following the surface of the bolts through the dam. Some leakage also occurred around the ends of the dam. Most of this passed through fissures in the rock entirely away from the dam. With a head of less than 50 feet there was no leakage of any kind through the concrete or through a construction joint in the dam.

Under a head of 50 feet a small moist spot, about 4 by 7 inches, appeared at the construction joint 15 feet above the base of the dam, due apparently to seepage through this joint. Under a head of 60 feet enough moisture came through the

construction joint at an elevation of 20 feet from the base of the dam to wet an area about 7 feet long and 4 feet high. Also, in the same test, four or five small patches of moisture appeared at the construction joint 55 feet above the base of the dam. These patches were not larger than one foot in diameter.

Under the head of 50 feet rough measurements were made from which it is estimated that the total leakage was about 6 gallons per minute. Of this it seems fair to estimate that 95 per cent came through the fissures in the rock. Under the head of 60 feet the leakage was considerably larger, but the percentage which came through the dam appeared even less than under the 50-foot head.

Recent Progress

The testing staff has moved to offices in Los Angeles, where thousands of field records are being tabulated, graphed, and studied. Good progress is being made upon this work. Thirteen load tests which were made up to and including September 23, 1926, have already been tabulated and partly plotted.

At the testing bureau of the University of California, the experiments with test specimens made of the same kind of cement and aggregate used in the construction of the Stevenson Creek Dam are being continued. These tests are being made to determine the modulus of elasticity and Poisson's ratio. Flow tests have been started on concrete cylinders maintained water soaked and air dried. Preliminary tests have been started to determine the permeability of the concrete.

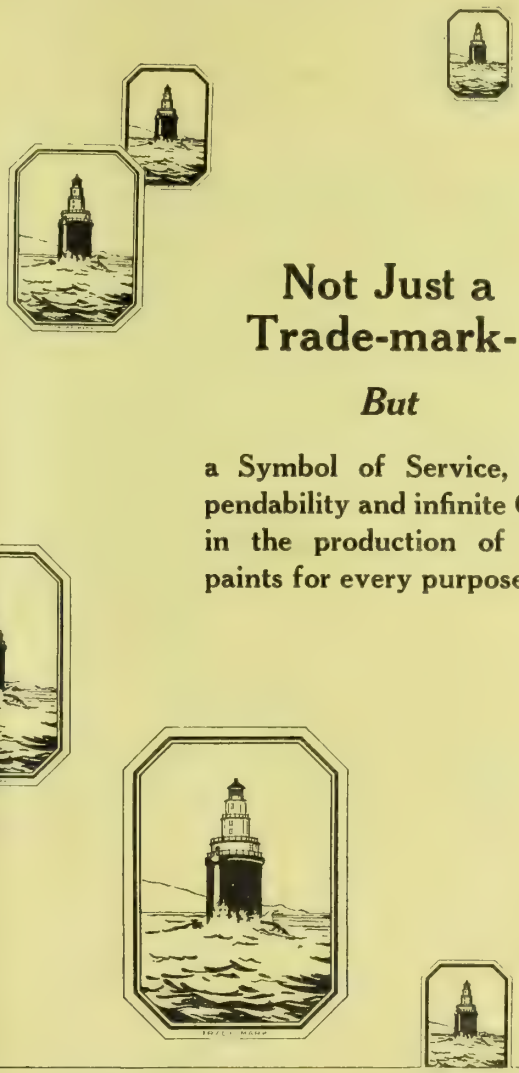
On November 27th an extraordinary flood occurred on Stevenson Creek. The under-sluice of 4x7 clear opening apparently became clogged up, and the water passed to a depth of about three feet over the rest of the dam. Immediately after the maximum flood was over H. W. Dennis and W. A. Slater made an inspection of the structure. The dam showed no apparent damage, in spite of this rather crucial test.

There are indications that the pond above the dam has been filled with debris to a depth of about forty feet, which was washed down by the torrents.

The unusual load conditions to which the test dam have been subjected during this flood is a most striking illustration of the truly remarkable strength of dams of the arched type.

Spring Valley to Grant Right of Way

Spring Valley Water Company has applied to the California Railroad Commission for authority to grant a right of way to Great Western Power Company of California for a pole line over lands of the water company in San Mateo County.



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WATER PURIFICATION

How Beverly Hills, Calif., Is Solving Its Problem of Water Purification

ONE of the most interesting problems of water purification is now being solved by the city of Beverly Hills, California. This work is under the direction of Salisbury, Bradshaw, and Taylor, consulting engineers of Los Angeles. Ray L. Derby, resident engineer for the firm, has spent more than eighteen months on this special problem, and is now about to complete the experimental plant, which is the forerunner of the main installation.

The major part of the domestic water supply of this community comes from deep wells lying on the outskirts of the city. To make the problem more intricate, each of these wells has an entirely different analysis, the water varying from 150 parts sulphates and 30 parts chlorides, to 50 parts sulphates and 130 parts chlorides, to the million. The hardness varies from 13 grains to 28 grains, and will average well over 20 grains per gallon.

Well	Casing Size Inches	Depth Feet	Output Miners Inches	H_2S P. P. M.	Iron P. P. M.	Hardness $CaCO_3$ P. P. M.	Total Solids P. P. M.
City No. 1	16	383	52	7.0	0.3	243	471
Gold Seal No. 1	16	315	15	7.0	0.3	261	581
Gold Seal No. 2	16	324	30	14.0	0.3	282	536
Gold Seal No. 3	16	419	35	9.0	1.0	170	621
Willows No. 1	10	320	34	1.0	0.2	230	606
Willows No. 5	16	540	33	4.0	0.1	402	627
Willows No. 6	16	298	25	5.0	0.5	421	555
Beverly Vista No. 1	16	296	16	18.0		205	396
Beverly Vista No. 3	16	325	29	20.0			603
Tatum No. 1	15	340	25	4.0		208	620
Preuss No. 1	14	367	30	7.0		314	487
La Cienega No. 1	14	278	55	6.0	0.12	290	597

The water consumption per capita of the community is rather large, averaging about 150 gallons during the winter months, and nearly 500 gallons during the summer months. This extremely high rate during the summer months is due to the large amount of lawn irrigation, it being estimated that four-fifths of the total consumption is used for this purpose.

The chief source of annoyance seems to be the high H_2S content. Some time ago an aeration plant was installed at a central point near Preuss Road to aerate all water. The original plant consisted of a spray pond, wier chamber, settling pond, and pump room. The sprays were housed over, and the freed H_2S gases drawn off by means of fans. These gases were led to a 30-foot stack, and burned with gas. This method was found to work quite successfully for a while, but in a short time complaints began to come in from the citizens regarding the taste of the water, describing it as having a "musty," "moldy," or "old rain barrel" taste. At first it was thought that the aeration was inefficient, so that tests were at once made, which showed the following:

	P. P. M. of H_2S
Water at inlet to plant	8.2
Water under sprays	4.3
Water at outlet of settling pond	3.6
Water in pump room	3.0
Water in pump line 3800 ft. from plant	0.8
Water in pump line 8000 ft. from plant	0.4

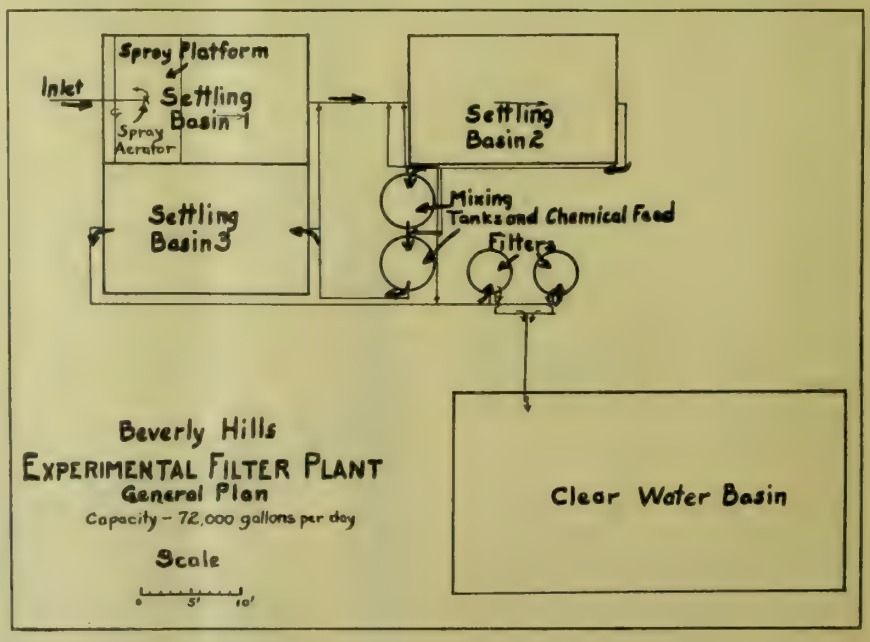
From these results it was apparent that the aeration was inefficient, and that time is an important factor in the elimination of the H_2S.

In order to increase the efficiency of the aeration more sprays were added, burners were installed, and the stacks raised an additional 30 feet to a total of 60 feet above ground. This largely eliminated the odor nuisance from the freed H_2S gas, and reduced complaints from this source. As previously stated, time of retention was found to be an important factor, so experiments were conducted to determine the exact effect that these two factors made.

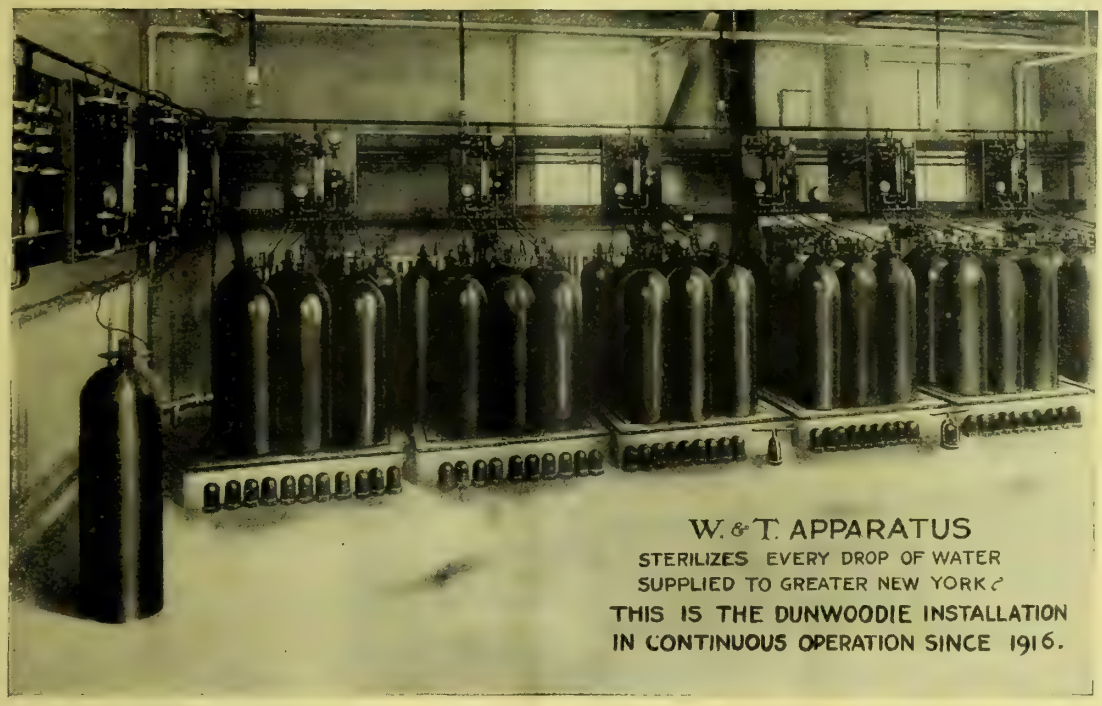
	H_2S Content Without Compressed Air P. P. M.	H_2S Content With Compressed Air P. P. M.
Inlet of Plant	8.2	8.2
Pump	4.1	3.9
1 hr. retention	2.9	1.3
2 hr. retention	2.7	0.9
4 hr. retention	2.2	0.2
8 hr. retention	1.3	0.2
24 hr. retention	0.5	0.2

As can be readily seen, the increased aeration was quite effective, but the time element was even of more importance. Based upon the results of these experiments, a new operating schedule will be adopted in the proposed filtration plant which calls for 8 hours' retention, the addition of alum, and possibly lime, 4 hours' additional retention, and then chlorination. The chlorination helps break the H_2S into free sulphur, and for this purpose, two Wallace & Tiernan chlorinators of 200-pound capacity have been installed. It was found by experiment that the best results were obtained when using 400 pounds of chlorine for the 5,000,000 gallons of water treated.

Upon the completion of this system, it was thought that the major portion of the troubles would cease, but they did not. Water users who were considerable distance from the central station still complained about the H_2S content, the taste, and odor. The engineers in charge commenced another investigation, and found a rather peculiar condition. When the original aeration and



Chlorination Must Be Dependable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chlorination takes place the H_2S gases are partially liberated, and a portion changed into free sulphur. The pipe lines of the water department are old, having been in use for considerable length of time, and during the period when there was no water treatment, algae and organic matter have found nesting places in the dead ends, and portions of the lines. This accumulated growth of algae and organic matter changes the free sulphur back to H_2S, and those users of water who are located at a distance from the treating plant, have conditions which are nearly identical to or worse than the original conditions.

In order to solve this new problem it was found that it would be necessary to filter the water after treatment. For this purpose the city is now installing a gravity type rapid sand filter, to handle 5,000,000 gallons per day. This plant will occupy a space of about two acres. The purpose of the installation is to filter out the free sulphur in the water, after the H_2S has been reduced to such in the aerators and assisted by chlorination. An experimental filter plant is now being installed to determine beforehand the exact effect that filtration will have, and if it will be necessary to provide additional treatment before delivering into the mains.

Nevada Project on Sound Basis

(*Continued from Page 17*)

daries can be considered as free of charge to the landowners. It will, therefore, be necessary for the land to stand only the cost of the local diversion works and distribution canals.

On March 6, 1925, a bond issue of $7,250,000 was approved by the voters of the district and an initial block of $6,000,000 was subsequently sold to finance construction. Contracts for the more important elements of the mountain storage works were let in July, 1925, but due to delay in the receipt of Federal Power Commission permits, construction did not commence until November 6th. Contracts for the remainder of the work, including the initial distribution system, were let in May, 1926.

The work now under way consists of five tunnels, two dams, one of which will be the second largest rockfill structure in the country, 2½ miles of flume, 6 miles of open canal and several long wood-stave siphons. All work is rapidly nearing completion with the exception of one long tunnel (4 miles long) which will require about one year longer than the other work. Present indications are that the delivery of water into Lake Spaulding and collection of revenue therefrom will commence next spring and that abundant mountain water will be available in the district at the beginning of the 1927 irrigation season.

Application Filed by Arizona on Damsite at Bridge Canyon

Application for a preliminary permit authorizing the building of a power and irrigation project on the Colorado river at Bridge canyon has been filed with the Federal Power Commission in the name of the State of Arizona by C. M. Zander, executive secretary of the board of directors of state institutions.

Specifications accompanying the maps filed with the application set forth that the capacity of Bridge Canyon reservoir would be 6,238,000 acre feet. The dam would be 825 feet high, with its crest 1,232 feet above sea level, according to E. C. LaRue in his report of the survey made in 1923. The spillways would extend through tunnels leading from the side of the river. The power plant would be below the dam on the south bank of the stream, and would have a capacity of 1,300,000 horsepower. Water for irrigation purposes would be diverted through a tunnel 6 miles long to Spencer canyon, thence through a 66 mile tunnel to Yucca, flowing through an open canal and a short tunnel down the canyon. The entire route for the proposed canal is described. Altogether, it is set forth that the project would irrigate 4,000,000 acres of land.

Will Issue $4,000 Note

Euclid Avenue Water Company, operating in the vicinity of South Pasadena, Los Angeles County, has been authorized by the California Railroad Commission to issue its unsecured promissory note in the sum of $4,000 payable in three months, with interest at not exceeding seven per cent per annum.

Grants Permit to Sell Water Plant

Howard Jones and Madge Jones, his wife, have been granted authority by the California Railroad Commission to sell a public utility water plant known as the Melrose Boulevard Tract Water Plant, located in the city of Oakland, to George Kerry and Nettie Kerry, his wife.

New System for Subdivisions

The California Railroad Commission has granted a certificate of public convenience and necessity to Frans Nelson & Sons, Inc., to operate a water system in Tracts Nos. 5470, 5737, 5965, 5966, 6069, 6229, and 7509, Los Angeles County, and has established a flat rate of $1.50 per month for residence service.

Wants Permit for San Juan-by-the-Sea

San Juan Water Company has applied to the Railroad Commission of California for certificate to operate a public utility water system in the townsite of San Juan-by-the-Sea, Orange County; said plant having been operated heretofore by Aaron Buchheim, under the fictitious name of Buchheim Water Company.

operated heretofore by Aaron Buchheim, under the fictitious name of Buchheim Water Company.

Grants Hearing on Rate Amendment

The Railroad Commission of California has granted a hearing to Sonoma Water and Irrigation Company in the matter of that company's application for permission to amend rates, and set the hearing before Examiner Austin on Thursday, December 23, 1926, at 11:00 a.m., in the city hall at Sonoma County.

Asks Permit to Sell System

William F. Waite, owning and operating a water system in the vicinity of Agua Caliente, Sonoma County, has applied to the Railroad Commission of California for permission to sell said system to L. F. Cowan for the sum of $5,000, together with 50 shares, par value $100, of common stock of Sonoma Water and Irrigation Company.

Fixes Water Sale Terms

The Railroad Commission of California has approved an agreement between the Pacific Gas and Electric Company and Roseville Water Company, providing for the sale by the former to the latter of water for a term of 30 years from June 16, 1926, at the rate of 16 cents per miner's inch day, with a monthly minimum payment equal to the value of six miner's inches per day at 16 cents per miner's inch during each month.

Sets Water Rates for Tract

A certificate has been granted by the California Railroad Commission to Stearns & Stearns, Inc., to operate a water utility serving residents of Tract No. 6728, Los Angeles County, and has established a monthly flat rate of $1.50 and a minimum meter rate of $1.50 for 500 cubic feet or less per month, and rates of 20 cents per 100 cubic feet for water up to 2,000 cubic feet per month, and 15 cents per 100 cubic feet for all water in excess of 2,000 cubic feet per month.

Moreno Co. Asks Use of Tunnel

Moreno Water Company and Moreno Mutual Irrigation Company, serving water to stockholders and subscribers in the Moreno Valley, Riverside County, have filed a complaint with the Railroad Commission of California against Hendrick Ranches, owning a tunnel which complainants desire to be allowed to use for the transportation of water from its point of development outside the Moreno Valley to ranches within the valley, and asking the Railroad Commission to declare Hendrick Ranches a public utility and to fix rates for the use of said tunnel, and to require defendants to allow said tunnel to be used for that purpose.

Asks Permit for New Stock Issue

El Pismo Water Company, supplying water to the town of Pismo Beach, San Luis Obispo County, has applied to the Railroad Commission of California for authority to issue to each of its incorporators one share of its common stock for par, $10.00 per share, to issue 1500 shares of its common stock and 1500 shares of its preferred stock to the incorporators in exchange for the properties, accounts and business of the public utility company known as Citizens Water Association, which has recently been administering the properties; and to issue 1500 shares of its common stock and 3,000 shares of its preferred stock for cash at $10.00 per share, without deduction, for the purpose of financing additions and betterments to said system.

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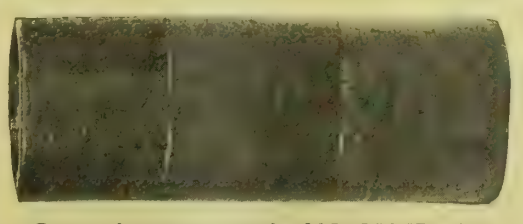

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SEWAGE DISPOSAL

Metropolitan Sewer Plan of Los Angeles County Sanitation Districts

By A. K. WARREN
Chief Engineer, Los Angeles Sanitation District

FOR several years prior to 1923, communities in Los Angeles County outside of the City of Los Angeles and notably those to the immediate south of the city, were very much concerned with the problem of sanitary sewage disposal from their increasingly populous cities and towns. Several attempts were made by different municipalities to effect means of sewage disposal through the medium of local sewage treatment plants, but in each instance, excepting where expansion was possible on sewage treatment works which had been erected during the early days of settlement at a time when the surrounding territory had not attained the value which has become attached to it since 1920, the plans were thwarted by injunction or incorporation of the area surrounding the proposed site; and as late as 1923 nearly all of the rapidly growing cities were still compelled to continue the use of the cess pool method of sanitary sewage disposal.

This has had its effect upon growth, with particular reference to industrial growth, which, normally, would and does suffer intensely from the lack of proper sewerage facilities.

During the early part of 1922 certain communities in the area to the south of Los Angeles City, (incorporated in what is now County Sanitation District No. 1) attempted to consolidate the several communities and their environs into a Sanitary District for the purpose of disposing of the sewage at a central treatment plant or otherwise, but found that under the laws then existing it was impracticable. Prior even to this action, three cities in the Santa Monica Bay area, viz., Manhattan Beach, Hermosa Beach and Redondo Beach, attempted to get together on a tri-city means of sewage disposal, but found themselves unable to agree either upon a proper means or suitable site.

County Sanitation District Formed

The need of inter-community effort in these areas resulted in the enactment, by the State Legislature, of the County Sanitation District Act which became a law in May, 1923. The Act provides that the governing body of a county may form into a district or districts, contiguous areas, for the purpose of effecting means of sanitary sewage disposal therefrom.

Immediate steps were taken to put the new law into effect, by the two districts at that time apparently most vitally concerned, the present County Sanitation District No. 1, and the South Bay Cities Sanitation District, with the result that these two areas were formed ino Sanitation Districts shortly after the passage of the act.

Realizing the benefits which would accrue from such methods of concerted community action, the residents of the present County Sanitation Districts Nos. 2, 3, 4 and 5 shortly followed with the formation of their districts so that within the course of a very few months following the passage of the act, southern Los Angeles County, lying outside of the limits of the city of Los Angeles was almost entirely blanketed with Sanitation Districts, the sole purpose of which was to provide a proper, economical and sanitary means of disposing of the sewage originating within their boundaries.

With so many Districts formed the plan for sewage disposal for southern Los Angeles County began to assume a truly metropolitan aspect, leading toward joint district action in the con-

System of Main Trunks Outlined

struction of an outfall to the ocean for the southern areas and contractual relations with the city of Los Angeles for the disposal of sewage through the City Outfall System for the Santa Monica Bay Cities and District No. 4.

Under the law the construction of the district sewage disposal system is financed

by bond issue voted by a two-thirds majority in the district or districts concerned. A plan of sewage disposal from the four districts south of Los Angeles city was submitted to the district citizens, which proposed conveying the sewage from the districts through a system of converging trunks to a screening plant located north and east of Harbor city, thence through four miles of conduit and three miles of tunnel under the Palos Verdes Hills to White Point on the south slope of the Palos Verdes Hills, thence through a submarine tunnel to a point approximately a half-mile from shore, discharging the screened sewage sixty feet under water at that location.

Bonds for the construction of such a system were promptly voted in Districts Nos. 1, 2 and 5. District No. 3 delayed its election on the grounds that it might possibly be more economical for the city of Long Beach, which is the principal factor in District No. 3, to construct its own ocean outfall and discharge sewage in San Pedro Bay approximately three miles from shore and in about 50 feet depth of water.

In the meantime the South Bay Cities Sanitation District and County Sanitation District No. 4 voted funds to construct trunks within the districts and connect to the present outfall sewer of the city of Los Angeles. Without further discussion of these two latter subjects, it is sufficient to note that both are completed and operating successfully to the benefit of the communities served.

It is worthy of note in passing, that the three municipalities in the South Bay Cities Sanitation District had been struggling for a period of nearly ten years with the problem of inter-community sewage disposal and had been utterly unable to cope with the situation prior to the passage of the County Sanitation District Act. It was less than two years before the system was partly in operation and only a little over, until its entire completion.

Joint Outfall Sewer to Ocean

That part of the County Sanitation District activities which is inviting the greatest attention at this time is the Joint District Outfall construction to the ocean. It concerns Districts Nos. 1, 2 and 5, in which funds have already been voted for its construction and Districts Nos. 3 and 8 which have been formed, but whose citizens have not as yet carried bond elections. It also concerns the area known as the Los Angeles Shoe String Strip and the San Pedro and Wilmington areas. As hereinbefore noted, the plan upon which the voting of construction funds was predicated is a joint district plan for conveying the sanitary sewage to the ocean at White Point.

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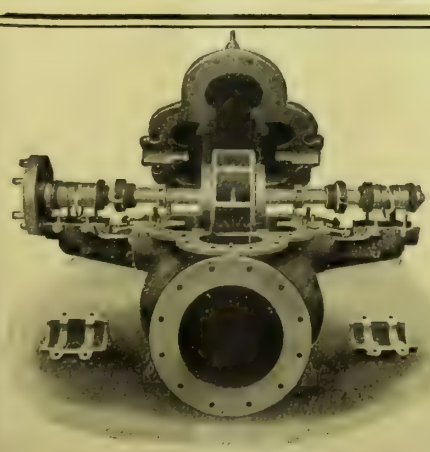

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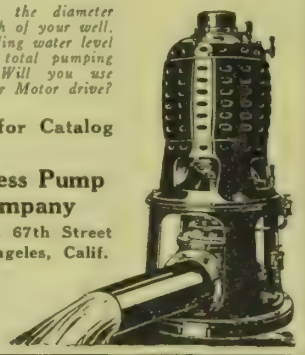

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Topographically the districts lend themselves well to the design of such a system. In the northern portion where flows will be comparatively light, steep gradients are obtainable, permitting the use of relatively small trunks with good velocities. As the trunks progress to the south and west the land flattens out, but good velocities are maintained because of increasing flows due to convergence of trunks, until finally after passing through the screening plant it is possible with the total flow accumulated at that point, to reach and discharge into the ocean by gravity, maintaining adequate velocities throughout.

SERVES ENTIRE METROPOLITAN AREA

Under the plans as outlined now, twelve incorporated cities, fifteen unincorporated communities and a large suburban and rural area, are to be served by this Metropolitan Outfall Sewer. Predications of total flow in the line are based upon an optimistic estimate of population for the year 1950 at which time it is predicted that there will be not less than four times the present population in the areas served. At the present writing the interior trunk sewers for each of the three districts are about fifty per cent complete.

Plans have been filed as ordered by the State Board of Health for the construction of an outfall extending in the same general direction as the original, but deviating slightly below the screening plant and with the southerly end of the Palos Verdes tunnel section located at the root of the Los Angeles Harbor Breakwater; thence along the breakwater and seaward in a submerged pipe to a point 9000 feet from the nearest point of shore, anticipating that District No. 3 and Districts Nos. 6 and 8 (more recently formed) as well as the Los Angeles City Shoe String Strip and San Pedro and Wilmington will participate in the cost of construction and use of the outfall.

It is the opinion of the Sanitation District engineers that the breakwater location offers advantages equal to those at White Point and that screened sewage discharged at either location, as outlined, will result in disposal without visual or olfactory nuisance or menace to health.

Irrigation District Extended

Boundaries of the Nevada irrigation district, California, have been extended to take in 62,000 acres of developed land in Placer county centering at Lincoln, by a unanimous vote of the board of directors meeting at Grass Valley, California, recently. In addition some 10,000 acres are to be served by direct sales. The district is based on a $6,000,000 water development project completed in the mountains.

Impounding Works of the San Diego Water System

(*Continued from Page 32*)

sources embraces progressive and complete development of the San Dieguito, San Diego and Tia Juana drainage areas.

PROBLEM OF SAFE NET YIELD

One of the most interesting and engrossing phases of local hydraulic engineering research is that of safe net yield and its allied subjects. Safet net yield may be defined as the quantity of water which a development will yield for continuous withdrawal, under continued climatic conditions in the future, similar to those of which we have record in the past.

The first of these conditions is rainfall, records of which at San Diego date back seventy-five years. The mean seasonal rainfall at San Diego is less than ten inches, increasing about one-half inch with each 100 feet of topographical altitude to the eastern rim of our watershed area.

The characteristics of this rainfall are the erratic, gross seasonal variations from the mean and the erratic occurrence of the rainstorms which go to make up the gross seasonal totals. The seasonal variations have run 50 per cent below mean and 25 per cent above mean.

The relationship between rainfall and runoff is far from direct or uniform. During subnormal seasons of rainfall, no runoff whatsoever has been known to reach a given reservoir, all rainfall being dissipated by the operation of such factors as capillary retention and vegetable transpiration. Under certain storm conditions it might happen that all the rainfall descending upon a certain area would reach a given measurement plane as runoff. This residual coefficient may then lie somewhere between 0 and 1, and runoff from certain drainage basins has actually been found to vary from nothing to ten times the seasonal mean which for the county watershed area is about 120 acre feet per square mile. Maximum runoff rates are estimated as high as 400 sec. feet per square mile.

EVAPORATION MOST IMPORTANT FACTOR

Once the runoff has been harvested behind one of our dam, the factor of evaporation immediately becomes operative. Evaporation is classified as gross and net, the latter being gross evaporation as offset or diminished by rainfall descending upon the same reservoir surface from which the evaporation has taken place, in the same time period. Since both evaporation and rainfall increase with altitude, the net evaporation is somewhat uniform for all portions of the county.

The controlling influences on safe net yield are therefore the size and mean

altitude of the tributary watershed, the size or impounding capacity of the control reservoir, ranging in ultimate developments between 4 and 6 B. G. per m. g. d., and its efficiency index, that is, the ratio of its volume to its exposed surface area. Reservoirs can and do differ greatly in this latter characteristic, which in turn affects reservoir performance.

The city is in possession of reservoir performance computations on practically every constructed and potential development in San Diego County. These computations necessarily predicate certain factors upon which there is no observation or record from other factors upon which there is observation or record. The computations may with safety be commenced with the 1883-4 season, the greatest locally within the period of rainfall records, and if safely carried over the critical dry period 1897-1904, will represent safe net yield in accordance with the definition before given. In general, the major developments of the county will show a safe net yield of between forty and fifty per cent of the mean seasonal runoff.

Often it may be shown that storage adjustment or transfer from one reservoir to another is advisable from a standpoint of monetary economy or water loss prevention. Such adjustment is made annually on the City's Cottonwood Otay System and is contemplated on the Sutherland, San Vicente, El Capitan projects.

Cost of Development

From all the preceding, it is evident that the cost of water locally must be high. Collection and transmission properties operated and controlled by the city have been acquired under bond issues and equivalent payments, totalling $11,000,000.00. Bonds on the distribution system represent another $3,000,000.00 investment. This capital investment represents over $600,000.00 of interest annually, at the interest rates on the actual bonds, most of which are not yet redeemed. The most recent figures place the cost of water at the tap at 24 1-10 cents per 1,000 gallons. This may be segregated into

	Cents	Per Cent
Interest	12.05	50
Depreciation	4.82	20
M & O	7.23	30
Total	24.10	100

The city is 100 per cent metered and the selling price of water is 20 cents per 1,000 gallons. The excess of cost over selling price naturally is met in the tax levy on assessed valuations. In the past, this procedure was regarded as advisable,

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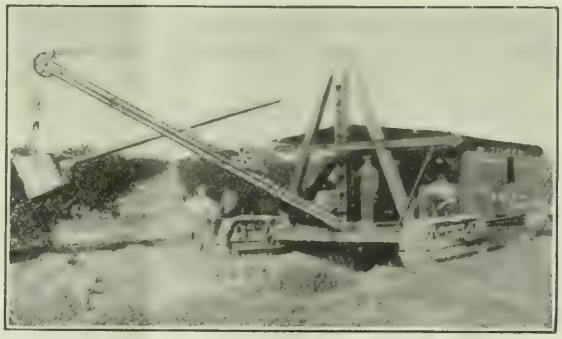
BAY CITY Land Dredges span the ditch, can dig any desired slope, and dump waste on both banks. BAY CITIES leave clean, wide berms, and can work up or down streams. One trip over the ditch is enough. The Shovel Type Dipper handles hard material in which other types of buckets cannot make a good showing.



At left—One yard BAY CITY Dredge digging and cleaning ditches in Florida Citrus Groves.

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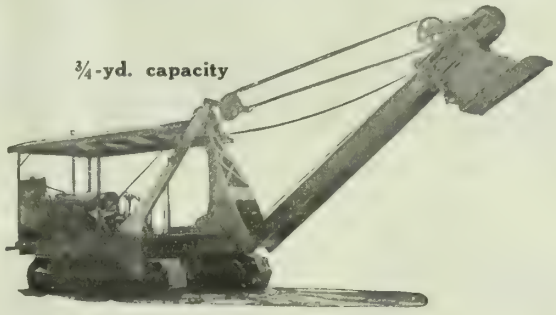

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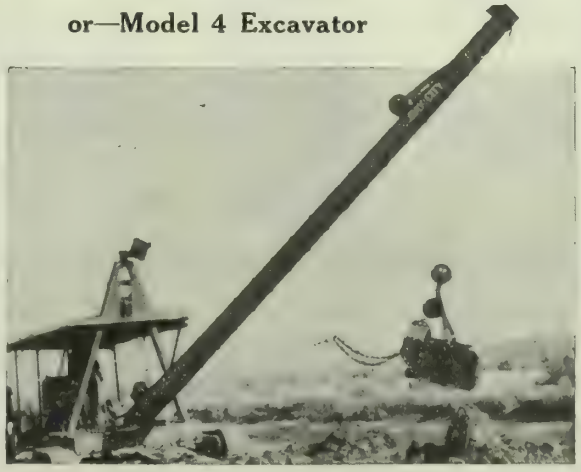

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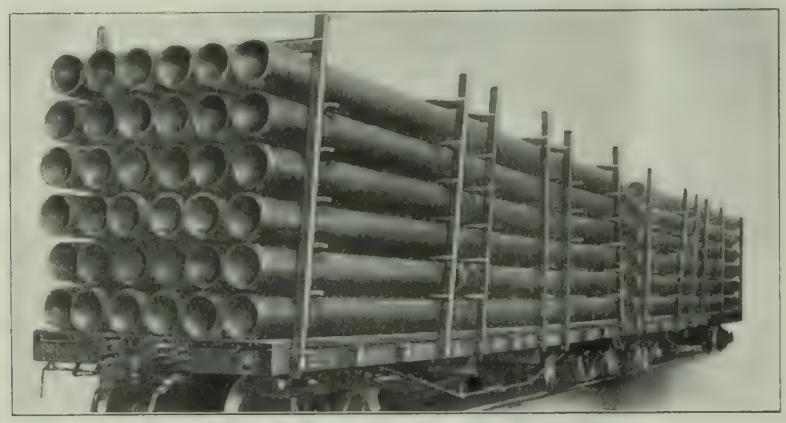

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in view of its effect on the non-user holding vacant property.

Locally, the day of cheap water properties or water rights is past. As water becomes more precious, the cost and valuation of these fundamentals will increase.

Contrary to general practice elsewhere, San Diego allows recreational use by the public, of its impounding reservoirs. The practice is in fact, universal in the county, and has a commercial aspect which is increasing in importance at least, as fast as regional population growth.

The physical factors surrounding the local methods of water development account for our ability to continue this practice with no deleterious effect upon the quality of the water. It appears that sparsely populated watersheds, large reservoirs, long storage (from one to ten years) common sense restrictions and ample sanitary facilities for the hunters and fishermen may perpetuate this unique privilege to our citizenry.

Quality of Developed Supply

The same factors which encompass and make difficult and expensive the development of water for San Diego, fortunately also are accountable for its high purity and attractive aesthetic quality. Watersheds of granite formation and by nature not fitted to dense agricultural population and subject to nine months' natural sterilization by air and sunlight, long storage implying immolation of bacteria are responsible for the high quality of the raw water.

With efficient plankton control, color, odors, and tastes may be kept to a minimum.

Surface temperatures follow a curve during the year similar to the mean air temperature. Draught is usually advisable from the upper strata of our reservoirs. Transmission to the city does not change these temperatures materially. In consequence, we receive water as warm as 80 degrees at our taps in midsummer and as low as 57 degrees in winter.

Even with a raw water suitable for consumption without any treatment, San Diego employs the purification processes of rapid sand filtration and chlorine sterilization. Three separate filtration plants are in use on three of the arteries entering the city. They are all of the pressure type and represent the greatest number of units employed on municipal water anywhere in the United States. Sterilization follows filtration.

San Diego's position on the honor roll of the seventy-seven American cities with over 100,000 population and her first position in the group of ten Mountain and Pacific state cities of that size in the 1925 typhoid fever survey of the

American Medical Association speak with significant eloquence of the purity of its water supply.

CONCLUSION

We feel that nowhere in the United States is the question of water supply development of greater vital importance to a growing community, endowed with many other and diversified blessings, than in San Diego. Local development is but a fourth as old as developments elsewhere in the United States, yet we feel that here man's interference has shapen the development of a supply in greater measure than where water is less precious.

The involved relationship of the limited and sporadic natural gift of rain and the high cost of control and conversion of the resulting runoff to sustained duty is unique and intensely interesting. Forty years ago the first settler's needs stood impotently by, while wild floods coursed to the sea. Step by step our water history will show these same floods brought to rest and released as silver threads for the community's use, growth and advancement.

Water Parley in Bakersfield Makes Conservation Plans

New Organization to Advance Water Fight Is Planned; Many Prominent Speakers

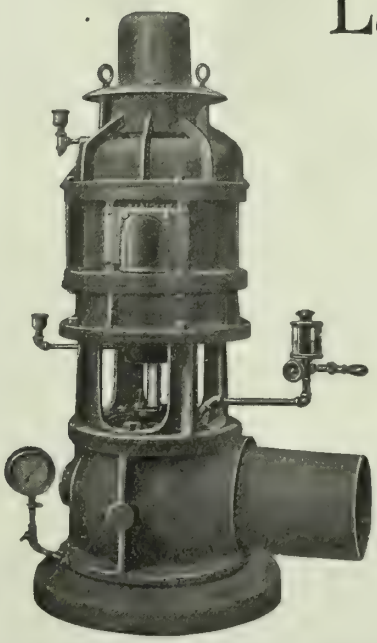
A conference on state-wide water interests, held in Bakersfield, California, in December, under the auspices of the California State Irrigation Association and the Kern County Chamber of Commerce, was attended by representatives of the agricultural districts of the "great valley" of California, delegates from the universities of the state, industrial representatives, and delegates from the San Francisco and Los Angeles chambers of commerce.

The water situation as it stands today was described by Frank Adams, professor of irrigation at the University of California. He declared that the initiative must be taken by the people, because the water problem is primarily their problem. "We must visualize this water situation," said Professor Adams, "not in terms of unit projects on single streams, but in the light of forming great water basins of the valleys."

Assurance that California can store her waters economically and profitably was given by M. E. Dittmar, delegate from the Sacramento valley. J. M. McIntosh, president of the Kern County Labor Council, promised the support of organized labor in whatever action might be taken in attacking the water problem.

8,000,000 gallons per day for Redlands

The City of Redlands has been operating Layne & Bowler Pumps for the past 13 years and has found them most satisfactory and efficient; now having capacity of 8,000,000 gallons per day, according to George S. Hinckley, City Engineer.



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INCREASE the life of your cement linings by painting them with LAYKOLD when first laid. This will imprison the water in the cement and allow it to reach a stronger set. It will also resist alkali action and will reduce skin friction, allowing your ditch to carry a larger load. LAYKOLD has a definite place in the Irrigation District and will solve many of your problems.

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WHO'S *WHO* AND WHO'S *WHERE*

IN THE WORLD OF HYDRAULICS

Personal Notes and Impersonal Observations About Men You Know

Ferd Schlapkohl, associate engineer and W. P. Eaton, senior engineering draftsman, have been transferred from the American Falls to the Owyhee project.

O. L. Rice, junior engineer, has been transferred from the Salt Lake City Basin investigations to the position of office engineer at Guernsey Dam, North Platte project.

G. K. Parker, who has been working with Mathews Construction Company as superintendent on the construction of the Melones Dam, has returned to his former position as chief engineer of the South San Joaquin Irrigation District.

William M. Green, who has been in charge of the investigation of the Great Basin reclamation project of Utah for the U. S. Bureau of Reclamation has resigned in order to join the J. G. White Engineering Corporation.

A. T. Strahorn, of the Department of Agriculture, who has been in charge of the soil survey on the Yakima, Yakima-Benton, and Kennewick irrigation districts in the State of Washington, has returned to his headquarters in Washington, D. C.

Arthur S. Bent, president of the Los Angeles Chamber of Commerce, headed a committee of ten men, representing various business organizations of California, at a conference on the Colorado River project at Colorado Springs early in December.

H. A. Rands, civil and hydraulic engineer of Portland, Oregon, has joined the engineering staff of the Washington Water Power Company, Spokane, Washington, which has under construction a dam, flow-line, and hydroelectric plant at Chelan, in central Washington.

R. M. Vaughan, valuation engineer and hydroelectric expert for the California State Railroad Commission, has resigned to become resident engineer at Prospect, Oregon, on the new hydroelectric development being made there by the California-Oregon Power Company.

Governor George H. Dern, Dr. John H. Widtsoe, William R. Wallace, and Oliver J. Grimes, of Utah, recently spent several days on the Yuma project, Arizona, for the purpose of getting first-hand information on the Colorado River situation in connection with the proposed Boulder Dam legislation.

Walker R. Young, construction engineer of the Kittitas division of the Yakima project, according to information recently received from the Denver office of the Bureau of Reclamation, visited the hydroelectric construction work being done by Grant, Smith & Co. at Lake Chelan, to obtain first-hand information on sand inundation and the use of "Celite" in concrete.

C. H. Pease, who has been secretary-manager of the Lower Rio Grande Water Users Association, has resigned that position and has been employed by Cameron County to represent the interests of the Delta before the department and before Congress in Washington in the matter of insuring permanent water rights on the Rio Grande through a treaty with Mexico and through effective river control.

The Boise project, Idaho, has had a number of changes recently in its personnel. J. B. Bond, manager of the project, has resigned to accept a position with the J. G. White Company in Mexico. William H. Tuller, former assistant manager, succeeds Mr. Bond as manager. Frank J. Hanagan, who has been treasurer of the project, has been elected secretary as well, taking over the duties of C. R. Kollerborn, resigned.

Charles P. Williams, formerly assistant chief engineer in the U. S. Reclamation Service, has opened an office as consulting engineer in Los Angeles. Mr. Williams has had about twenty years of experience in the study of water supply and storage possibilities, and the design, construction, operation and maintenance of irrigation works, dams, pipe lines, canals and drainage works.

Ivan E. Houk, engineer of the Bureau of Reclamation at Denver, and D. C. Henny, consulting engineer of Portland, Oregon, were in Los Angeles recently attending a meeting of the committee on Arch Dam Investigation.

A group of about 70 high school teachers from Los Angeles made a trip to Imperial Valley during the Christmas holidays for the purpose of seeing the location of the proposed Boulder Canyon dam and of visiting the various points of interest in the Imperial irrigation system.

Charles D. Marx, of Stanford University, Charles D. Paul, chief engineer of the Miami Conservancy Association, Dayton, Ohio, and Frederick H. Fowler, consulting engineer, of San Francisco, the committee appointed to act in an advisory capacity on the question of the San Gabriel dam, met in Los Angeles during the first half of January.

N. Shand and S. B. Shannon, engineers of the irrigation department of the South African government, are in the United States for the purpose of studying irrigation problems and seeing if any of the methods employed in this country are suitable for use in their district. They visited the Orland, California, project in December, and a little later spent some time in the Imperial irrigation district. They went over the levees and visited Laguna dam. From Imperial they expected to visit the Boulder dam site.

Professor David Weeks, of the University of California, has been studying the possibilities of converting the Altiplano, the high plateau region of Bolivia, into desirable farming and grazing land through irrigation. Professor Weeks is quoted as believing that the Altiplano can be made a desirable region for agricultural settlers, and that with modern irrigation the land can become as fertile as the best. The one great difficulty appears to be the lack of fuel, but it is believed that with the existing resources of water it will be possible to generate sufficient electrical energy to provide the needed heat and power.

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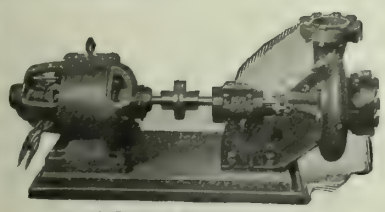

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OVERHEAD IRRIGATION

GETTING SOIL PENETRATION WITH OVERHEAD EQUIPMENT

By H. A. WADSWORTH

Assistant Professor of Irrigation, College of Agriculture, University of California

THE value of overhead sprinkling as a means of irrigation depends upon the effectiveness of this method in creating and maintaining a satisfactory soil moisture content. Soils vary in water holding capacity and permeability, fine-textured soils holding more moisture than coarser soils but "taking" water less readily. Plants suffer for water when the moisture content within the rooting zone drops below a point known as the wilting coefficient. The wilting coefficient for most soils may be determined in the laboratory with a fair degree of accuracy. If it can be assumed that the major concentration of feeding roots occurs in a definite soil stratum, a satisfactory method of irrigation would permit the application of water by such means and in such an amount that the soil moisture content in that stratum of soil may be maintained between these limits.

Sprinkler heads vary widely in capacities. This is due partly to differences in design and partly to the pressures for which various heads may be recommended to insure greatest uniformity of distriubution.

For heads commonly used for orchard irrigation, such as rotary sprinklers and certain types of long arm sprinklers, a discharge sufficient to cover the circle of coverage to a depth of one inch in four or five hours may be considered as typical. Geared sprinklers may, and usually do, discharge more than that indicated above. Solid heads of various makes differ widely in discharge under operating pressures.

Capacities Depend on Pressure

Since knowledge of the amount of water discharged by a single head is of great importance in the design of a sprinkler installation, tests have been run on a few modern heads under varying pressures.

A solid head popular in the citrus areas of the southern states was found to discharge 7.6 gallons per minute under a pressure of 35 pounds per square inch. Under a pressure of 20 pounds per square inch, the discharge dropped to 5.9 gallons per minute, and 10 pounds gave only 3.8 gallons.

Two makes of long arm sprinklers in common use in California showed almost identical capacities for similar pressures. These heads discharged 6.9, 5.3, and 3.8 gallons per minute when operated under pressures of 35, 20, and 10 pounds per square inch, respectively.

Capacity of Geared Sprinklers

As has been stated, geared sprinklers have greater capacities than either solid heads or long arm sprinklers. One geared sprinkler used in parks and on golf greens discharged 17.3 gallons per minute under a pressure of 35 pounds per square inch. Under pressures of 20 pounds per square inch and 10 pounds per square inch, the discharge was 13.4 and 9.4 gallons per minute, respectively.

When the discharge of a certain head under the recommended pressure is known, the time required for an application of one inch of water can be readily computed by the following simple formula:

If D=diameter of the wetted area in feet, and

G.P.M.=capacity of the head in gallons per minute, then

$$\frac{D^2}{G.P.M.\times 122} = \text{hours run required}$$

for an application of one inch on the wetted zone.

This equation is based upon the assumption that evaporation losses are negligible.

Holding Soil Permeability

Six sprinkled citrus groves in Los Angeles and Orange counties were sampled intensively for depth of penetration of irrigation water and soil moisture content during the irrigation season of 1925 to determine the effectiveness of irrigation by the sprinkling method. Three of these groves were on decomposed granite soils of low water holding capacity and easy permeability, while three were on soils of finer texture into which water penetrates less readily. In most cases the groves were sampled immediately before and after each irrigation. In every case samples were taken from the same limited areas at each time of sampling. Although this method of sampling did not necessarily indicate the average moisture content in the entire grove at the time of the sampling, it did give a fairly accurate idea of the soil moisture history in the small plots under consideration.

In the case of the three groves on decomposed granite soils, the sampling indicated that satisfactory irrigations had been accomplished. In none of these groves did the soil moisture content in the principal rooting zone fall below the wilting coefficient between March and November. Adequate penetration of moisture at each irrigation was, in most cases, indicated by an increase in soil moisture content in the fourth foot of soil. The effect of irrigation was sometimes evident in the fifth and sixth foot. It is to be noted that these groves were managed by men experienced in sprinkler operation. Sprinkler heads were well adapted to conditions, and factors determining the required period of operation were well understood. A great measure of the success of overhead sprinkling in these groves can probably be attributed to the experience of the operators.

Inadequate Penetration

Inadequate penetration of irrigation water was noted in each of the three sampled groves on the heavier soil. In most cases irrigation resulted in an increase in the moisture content of the surface foot alone, the greater depths being at, or dangerously near, the wilting coefficient when the residual soil moisture from winter rains had been depleted by plant withdrawals. In one case, however, sprinklers were operated for a period four times as long as usual and an increase in the soil moisture content was noted to a depth of six feet. This fact together with scattered observations upon

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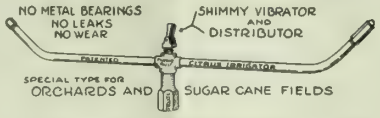

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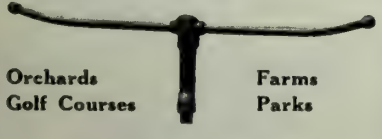

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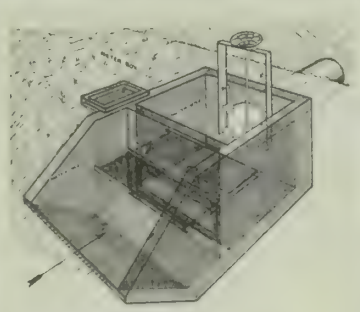

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the penetration secured in difficult soils by overhead sprinklers in other areas seems to indicate that adequate penetration in such soils can be obtained with experience, patience, and proper care in the selection and use of equipment.

What Overhead Irrigation Does

A bulletin recently issued by the Buckner Manufacturing Company enumerates the following advantages of overhead irrigation:

Overhead irrigation saves cost of furrowing and of labor for men to pilot water around with hoes and shovels in an effort to get it to the trees and keep it out of low spots.

Saves fertilizer by not washing it away to a low spot. Eliminates mud holes and boggy spots as well as dry spots. Saves thousands of gallons of water which ordinarily runs down gopher holes, and also deep percolation in sags.

Washes soot and dirt off the trees and plants and gives them a chance to breathe and become healthy. Eliminates erosion.

Operates perfectly on a hillside, just the same as a gentle rainfall without run off and waste water. Saves acres of waste by ditch elimination. Gathers nitrogen from the air and feeds it to the trees and plants. Keeps the fruit clean, which brings better prices.

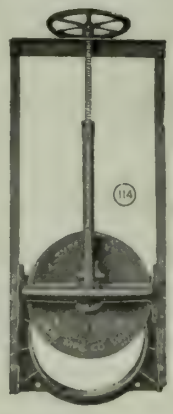
On hot days it reduces the temperature, causes humidity and eliminates or reduces June drop. On cold nights it is a proven frost protection as it raises the temperature and washes the frost from the foliage.

Overhead irrigation will eventually eliminate the use of the filthy smudge pot and the labor and expense of operating these pests which ruin the fruit and smoke up everything for miles around.

It washes insects and spiders from the trees and in many instances eliminates the cost of spraying. Overhead irrigation pays for itself in cover crop alone—which cannot be grown with furrow irrigation.

W. I. E. A. to Meet in L. A.

The next meeting of the Western Irrigation Equipment Association will be held in Los Angeles, California, January 28, 1927. As will be remembered the last meeting was held in San Jose, and one of the important subjects under consideration at that time was the form contract for the purchase of deep well pumps. It is expected that the ratification of this form will have been completed by the time of the next meeting and that progressive measures can be taken to permanently establish it in the sales departments of the various equipment manufacturers.



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Reclamation of Rio Grande Will Treble Value of Land

Draining water from lands too wet to grow anything and running it onto lands too dry to grow anything, was given as one of the objectives of the Middle Rio Grande Conservancy District in a recent address by P. S. Donnell, of the University of New Mexico. Although protection of the river channel as the largest source of irrigation water in this arid region is essential, the preservation of that large percentage of moisture which is lost through evaporation on the water-logged areas is a big factor in the development of the project, said Mr. Donnell.

New Maps of Umpqua River

Topographic surveys of the Umpqua River, one of the most valuable water-power streams in Oregon, were made by engineers of the Department of the Interior, Geological Survey, in 1925, and the resulting maps have just been issued by the Geological Survey in three colors, on the large scale of half a mile to the inch, with contour intervals of 20 feet on land and 5 feet on the water surface.

The upper end of the river, from Soda Springs to Bradley Creek, 31 miles, and Lake Creek from the mouth to Diamond Lake, 12 miles, are mapped on a scale of 4,000 feet to the inch with the same contour intervals as the remainder of the river. Umpqua River and North Umpqua River are shown from Scottsburg, at the head of tidewater, to Bradley Creek, a distance of 181 miles; Mill Creek from the mouth to the head of Loon Lake, including the Loon Lake Reservoir site, 17 miles; Calapooya Creek from the mouth to Oakland, 13 miles; Steamboat Creek for 9 miles above the mouth; Fish Creek from the mouth to Rough Can Creek, 9 miles; Clearwater River from the mouth to Lava Creek, 10 miles, and Lake Creek from the mouth to Diamond Lake, 12 miles.

Seventeen dam sites with cross sections at each are shown on a scale of 400 feet to the inch with a contour interval of 10 feet. The Loon Lake and Coles Valley reservoir sites and a sketch covering 8½ miles of possible canal location below Glide are shown on a scale of 1000 feet to the inch, with a contour interval of 10 feet. Profiles are shown for all the streams. The plan and profile of Umpqua River above Scottsburg, North Umpqua River, and tributaries is published in 5 plan sheets and 4 profile sheets. The maps showing dam and reservoir sites and canal location are published in 7 sheets. These maps can be purchased from the Geological Survey for 10 cents a sheet.

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SURVEY *of* HYDRAULIC DEVELOPMENT

As Shown by Official Records of the Month -- Local, State, and Governmental

Applications Filed

Among the more important applications for permit to appropriate water filed with the State Department of Public Works, Division of Water Rights, California, during the month of December, 1926, were the following:

Application 5290 (Los Angeles County)—City of Alhambra, c/o Water Department, Alhambra, Calif., for 41.4 cubic feet per second and 30,000 acre feet per annum from San Gabriel River. To be diverted in Section 14, T 1 N, R 10 W, S. B. M. for municipal purposes. Estimated cost $1,000,000.

Application 5291 (Riverside County)—Hemet Valley Well Owners Association, c/o F. W. Stetson, C. E., Hemet, Calif., for 4,000 acre feet per annum from Bantista Creek tributary to San Jacinto River. To be diverted in Section 35, T 5 S, R 1 E, S. B. M. for agricultural purposes on 3,428 acres. Estimated cost $500.

Application 5292 (Los Angeles County)—William H. Heise, 855 S. Figueroa Street, Los Angeles, Calif., for 5.00 cubic feet per second from Rock Creek. To be diverted in Section 6, T 4 N, R 9 W, S. B. M. for irrigation and domestic purposes on 760 acres.

Application 5297 (Santa Cruz County)—Felton Water Co., Felton, Calif., for 0.23 cubic foot per second from Bennett and Shingle Mill Creeks tributary to Fall Creek and San Lorenzo River. To be diverted in Section 21, T 10 S, R 2 W, M. D. M. for domestic purposes. Estimated cost $5,000.

Application 5298 (Santa Cruz County)—Felton Water Co., Felton, Calif., for 0.23 cubic foot per second from Bennett and Shingle Mill Creeks tributary to Fall Creek and San Lorenzo River. To be diverted in Section 21, T 10 S, R 2 W, M. D. M. for agricultural purposes on 283.4 acres. Estimated cost $5,000.

Application 5301 (Los Angeles County)—U. S. Forest Service, 629 Federal Bldg., Los Angeles, Calif., for 0.25 cubic foot per second from Branch of Clear Creek tributary to Big Tujunga Canyon. To be diverted in Section 8, T 2 N, R 12 W, S. B. M. for agricultural purposes. Estimated cost $1000.

Application 5302 (Lake County)—Mirabel Park Association, c/o F. O. Jones, Sec., R. F. D. No. 3, Box 1338, Napa, Calif., for 0.20 cubic foot per second from St. Helena Creek and its tributaries tributary to Putah and St. Helena Creek. To be diverted in Sections 23, 25, 26 and 27, T 10 N, R 7 W, M. D. M. for domestic, irrigation and recreational purposes. Estimated cost $15,000.

Application 5304 (Orange County)—San Juan Water Co., 1013 Pacific Finance Bldg., Los Angeles, for 3,000 acre feet per annum from San Juan Creek tributary to Pacific Ocean. To be diverted in Section 12, T 8 S, R 8 W, S. B. M. for domestic and irrigation purposes on 1,000 acres.

Application 5305 (Orange County)—J. Clark Smith, c/o W. G. Irving, Suite 2, Evans Block, Riverside, Calif., for 4,000 acre feet per annum from San Juan Creek tributary to Pacific Ocean. To be diverted in Section 28 and 33, T 7 S, R 7 W, S. B. M. for irrigation and domestic purposes.

Application 5310 (Del Norte County)—Walter G. Muncy, Crescent City, Calif., for 3.00 cubic feet per second from Kelley's Gulch tributary to Middle Fork Smith River. To be diverted in Section 27, T 17 N, R 2 E, H. M. for power and domestic purposes. 12 T. H. P. to be developed. Estimated cost $2500.

Application 5311 (Siskiyou County)—H. D. Brown, c/o Tebbe & Tebbe, Attys., Peters & DeWitt Bldg., Yreka, Calif., for 15.00 cubic feet per second from Big Spring tributary to Sullpway Creek and Sacramento River. To be diverted in Section 17, T 40 N, R 4 W, M. D. M. for irrigation and domestic purposes on 682.11 acres. Estimated cost $10,000.

Application 5312 (Modoc County)—Louis Avanzino, Alturas, Calif., for 455 acre feet per annum from Willow Creek tributary to Clear Lake Reservoir. To be diverted in Section 3, T 45 N, R 10 E, M. D. M. for irrigation purposes on 728.0 acres. Estimated cost $6500.

Application 5315 (San Bernardino County)—Frank J. Golden, Hobart Bldg., San Francisco, California, for (1) 10,000, (2) 10,000, (3) 20,000 acre feet per annum from (1) Arrastre Creek, (2) Rattlesnake Canyon, (3) Antelope Creek, tributary to Mojave Desert. To be diverted in (1) Section 2, T 1 N, R 5 E, S. B. M.; (2) Section 22, T 3 N, R 2 E, S. B. M. and (3) Section 19, T 3 N, R 3 E, S. B. M., for agricultural purposes on 13,000 acres.

Application 5316 (San Joaquin County)—Lilo M. Perrin, Betty Weller, Harry T. Hays, John C. Hays and Hays McMullin, c/o Ohm & Raab, 517 East Market St., Stockton, Calif., for 77.5 cubic feet per second from San Joaquin Inyo and Stanislaus River tributary to San Joaquin River. To be diverted in Sections 36 and 22, T 2 S, R 6 E, M. D. M. and Sections 4 and 9, T 3 S, R 7 E, M. D. M. for irrigation purposes on 6,200 acres.

Application 5317 (Mendocino County)—Lloyd F. Cook, Box 3232, Hartsook, Calif., for 0.60 cubic foot per second from South Fork Eel River tributary to Eel River. To be diverted in Section 24, T 5 S, R 3 E, H. M. for irrigation and domestic purposes on 50 acres. Estimated cost $900.

Application 5318 (Lassen County)—John Andrew Mehling, San Francisco, Calif., for 10,000 acre feet per annum from Flood waters of Storm Creek tributary to Honey Lake Drainage area. To be diverted in Sections 12 and 13, T 31 N, R 14 E, M. D. B. and M. for irrigation purposes on 8000 acres. Estimated cost $150,000.

Permits Issued

Among the more important permits to appropriate water issued by the Department of Public Works, Division of Water Rights, California, during the month of December, 1926, were the following:

Permit 2690, Application 4963 (Butte County)—Issued to Edward Schirmer, Gridley, Calif., December 31, 1926, for 4 cubic feet per second from Lateral "E" of Reclamation District 833 in Section 33, T 18 N, R 2 E, for irrigation of 428.6 acres of rice in Section 33. Estimated cost $1000.

Permit 2691, Application 4993 (Butte County)—Issued to Grover B. Estes and Victor Hoag, Gridley, Calif., December 31, 1926, for 2.5 cubic feet per second from Hamilton Slough or Main Canal of Reclamation District 833 in Section 28, T 18 N, R 2 E, for irrigation of 100 acres in Section 28. Estimated cost $1000.

Permit 2692, Application 5009 (Butte County)—Issued to F. H. Smitton, Gridley, Calif., December 31, 1926, for 3 cubic feet per second from Hamilton Slough or Main Canal of Reclamation District 833 in Section 36, T 18 N, R 1 E, for irrigation of 202 acres in Section 36.

Permit 2693, Application 5010 (Butte County)—Issued to F. H. Smitton, Gridley, Calif., December 31, 1926, for 2.35 cubic feet per second from Lateral "E" of Reclamation District 833 in Section 36, T 18 N, R 1 E, for irrigation of 94 acres in Section 36.

Permit 2684, Application 5209 (San Joaquin County)—Issued to T. Lorenzen, et al, Stockton, Calif., December 23, 1926, for 12.62 cubic feet per second from San Joaquin River in Section 15, T 2 S, R 6 E, for irrigation of 1010.2 acres near point of diversion. Estimated cost $12,000.

OREGON

Among the more important applications for permit to appropriate water filed in the office of Rhea Luper, State Engineer of Oregon, during December, 1926, were the following:

Lee Williams, of Newport, Oregon, covering the appropriation of water from Depot Creek, tributary of Depot Bay on the south for domestic supplies in Lincoln County, with an estimated cost of $2,000.

Jacob Kaser, of Burnt Ranch, Oregon, covering the appropriation of water from the John Day River, tributary of Columbia River for irrigation of 36.8 acres in Jefferson County, with an estimated cost of $2500.00.

John Lowe, of Crawfordsville, Oregon, covering the appropriation of water from

Sallapooia Creek, tributary of Willamette River, for irrigation purposes.

Wells Gilbert, of Spalding Building, Portland, Oregon, covering the appropriation of water from Spring at source of unnamed stream tributary of Willamette River, for irrigation.

Wells Gilbert, covering the appropriation of water from unnamed stream, tributary of the Willamette River, for irrigation purposes.

Mrs. K. F. Hughes, covering the appropriation of water from Duggar Creek, tributary of Pine Creek, for the irrigation of 39 acres in Umatilla County, with an estimated cost of $50.00.

Ed. Hulick, of Freewater, Oregon, covering the appropriation of water from Duggar Creek, tributary of Pine Creek, for the irrigation of 31 acres in Umatilla County with an estimated cost of $50.00.

Armco Changes Name

Effective January 1, 1927, the Armco Culvert and Flume Manufacturers Association became the Armco Culvert Manufacturers' Association. The change of name does not imply any change in the policy of the organization, the association explains. The organization will continue to devote its efforts to research in all matters relating to drainage and irrigation, and to educational publicity for making this information gained known to all those whom it will benefit.

The history of the development of Armco Culverts is a very interesting one, and recently the association published a small booklet dedicated to the anniversary of the development. Patents for the culvert were granted to James H. Watson, a sheet metal manufacturer of Crawfordsville, Indiana, in May, 1896. From the small beginning in the shop of Mr. Watson has grown the Armco Culvert Association, comprising twenty-nine members, with factories and plants located in nearly every principal city in the United States.

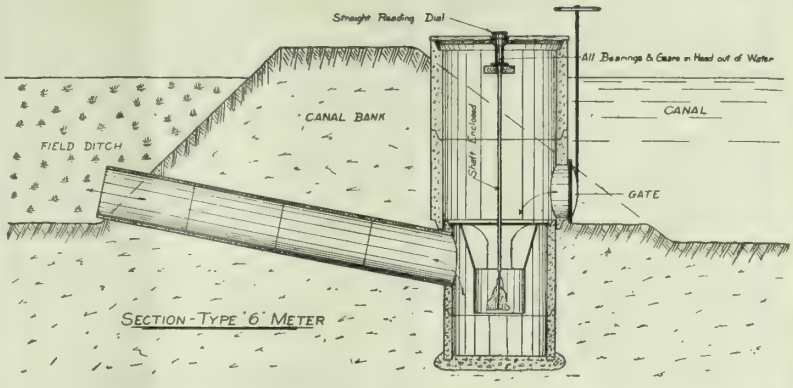
A well-organized plan for educational publicity was undertaken several years ago, and today corrugated culverts are being extensively used throughout the country.

Pipe Men Meet in Bakersfield

The California Association of Concrete Pipe Manufacturers held a one-day convention at Bakersfield on Saturday, January 8. It was voted to hold the annual midsummer convention in San Francisco on July 15 and 16, and to invite the Northwestern Concrete Manufacturers Association to join in the meeting.

About 1,000 acres of land will be added to the Woodbridge irrigation district, California, enabling it to issue bonds amounting to $250,000 to purchase the Woodbridge canal from the Stockton Mokelumne Water Company, according to a recent statement by W. J. Robinson, Jr., president of the company.

The RELIANCE METER



THE "Type 6" Reliance Irrigation Meter offers you standardized permanent construction at a very low first cost. Their sustained efficiency with a minimum of upkeep has been proven by 12 years usage. Cut shows installation of the 4 sec. ft. size in 24 and 30-inch concrete pipe. This is the standard type of setting adopted by many irrigation districts in Texas and elsewhere who are now equipping all their deliveries with this device. The "Type 6" meter is furnished in sizes ranging from ½ up to 16 sec. ft.

For further information and prices write—

RANDALL CONTROL & HYDROMETRIC CORP.
1014 E. Ninth St., Los Angeles, Calif.

Have You Seen the New Straight Drive PACIFIC PUMP?

Its exclusive feature—7½ to 50 h. p. motors interchangeable on the same head, an advantage of great economy. Each a compact unit; perfectly aligned; no flexible coupling. All parts easily accessible. PACIFIC PUMPS are remarkable for Silent, Smooth Service, Endurance and Economy.

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For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

PIPE

FOR IRRIGATION

The last word in automatic welding machinery is in operation at the MONTAGUE plant after a great deal of study and research work on how to produce the best kind of welding for the best kind of Pipe products.

Write for any or all of these catalogs:

Montague Well Casing 6-A
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MONTAGUE PIPE & STEEL CO

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Good garages near. Parking space too!

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POST STREET AT STOCKTON SAN FRANCISCO

Overlooking Union Square

Fletcher Joins "Caterpillar"

Extending to a new field its policy of providing highly trained specialists in various lines served by "Caterpillar" tractors, the Caterpillar Tractor Co. of San Leandro, California, and Peoria, Illinois, has announced the establishment of an Agricultural Department in charge of L. J. Fletcher, nationally known agricultural engineer who, until his affiliation with the "Caterpillar" organization, has been head of the Agricultural Division, College of Agriculture, University of California.

A farmer from his earliest days, Fletcher has come to the tractor manufacturer with a broad knowledge of agri-

L. J. Fletcher

cultural conditions and the application of scientific principles to farming of all types.

Born and reared on a general farm in Iowa, Fletcher graduated in agricultural engineering at Iowa State College. His graduation was followed by a year of farm work in the state of Washington, following which he joined the Agricultural Engineering Division of the University of California, and for the past seven years has been head of that department. During this period he has organized and conducted considerable extension work in tractor schools and similar projects.

In addition to his educational work, L. J. Fletcher has maintained a close contact with tractor and implement manufacturers, including in his work in this connection the chairmanship of the Exhibit Committee of the California Tractor and Implement Club, an organization of tractor and implement makers.

While the greater portion of his work has been in the Pacific states, his earlier interests in the mid-west have served to draw his constant attention to the problems of that section, and extensive studies have given him a familiarity with the agricultural situations in all sections of the world. Added to this, Fletcher has traveled widely and is well known to agricultural engineers in the country's leading educational institutions, as well as to machinery manufacturers, farm paper editors and others who are in constant touch with the agricultural pulse.

In 1925 he was invited by Secretary of Agriculture W. N. Jardine to become a member of the committee to prepare a national program for research work on farm operating equipment and he has, in addition, been prominently connected with the work of the American Society of Agricultural Engineers, having served in such capacities as first vice president, chairman of the College Division, and chairman of the Pacific Coast Section.

Mr. Fletcher will make his headquarters for the present at the Peoria factory of the Caterpillar Tractor Co.

Backfiller Has Many Uses

Nowadays a backfiller is also a light crane, with many uses. The new Buckeye backfiller, made by the Buckeye Traction Ditcher Co., Findlay, Ohio, is a good example of this common sense trend in equipment.

While it is primarily a backfiller, it can also be used to pull piling, handle pipe, batch boxes, forms, stone and steel, the company explains. Equipped with a clamshell, it will handle all loose materials and cleans up after excavation jobs. Its full circle swing, and adjustable-length boom increase its adaptability to this wide variety of purposes. Its full length Alligator traction takes it anywhere.

Another feature of this equipment is its quick and convenient control. All controls are located in easy reach at the operator's platform. The driver faces the work at all times. The machine travels, and is easily controlled, with the boom rotated in any direction. Under such conditions any mechanic of average ability can produce efficient results.

A high degree of ruggedness has been built into the machine.

The Beaumont irrigation district, California, has recently purchased approximately 212 acres of water bearing land at Oak Glen. The sale price was not announced but it is understood to have been around $45,000. The property is partly improved with 40 acres of bearing apple trees. It is probable that work will start immediately to develop water for use in the district.

For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

Oxy-Acetylene Welding Found Valuable in Waterworks Field

The centrifugal governor of a rotary water pump broke through the spindle. As immediate replacement was important the broken pieces were brought to the oxwelder for repair. This job is typical of many important small parts, of which the repair cost in materials and labor is far out of proportion to the actual value of the work done.

For such parts unusual care is required in preparation for welding. The latter is a feature of procedure control that always is important, yet often neglected. After correct alignment is provided for, the welding operation itself must be carried on, so the spindle will run true at completion of the job. This is important, not only to eliminate side motion in the spindle, but also to allow the plunger to run freely, and the pinion teeth to mesh accurately.

Clean Parts Essential

The first step in a job of this kind is to clean the pieces thoroughly of all oil, grease and dirt. The edges of the break should then be beveled by grinding to give a 90-deg. total vee all around. In a part of this kind, which is hollow drilled in the center, the chisel-edge bevel usually employed for round sections is not adaptable for obvious reasons. Simply grind a bevel all around nearly to the depth of the metal surrounding the drilled central section.

A carbon rod of the proper diameter, or one ground accurately to the correct size, will be a great help in aligning the pieces, and in controlling the metal so a minimum of drilling or reaming will be required after the job is done. Vee blocks and shims should be used on the welding table top to obtain final alignment.

Parts of this kind being steel, good quality steel welding rod should be used. For a strong, easily machined job, "high test" welding rod is recommended.

Maintaining Alignment

After tack-welding the parts in two places, the final welding can be done with the spindle either in a horizontal position, or set up vertically. The important thing is to maintain alignment, to weld through to the bottom of the vee and to obtain thorough fusion between the metal in the spindle and that from the welding rod. It will probably be easier to do this with the part in the horizontal position because of possible difficulty in fusing the top section if it should be set up for vertical welding.

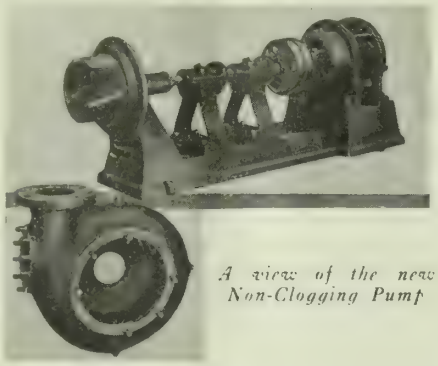
It may be desirable to reinforce the weld slightly for added strength. If no reinforcement is desired, build up the weld just a little above the level of the adjacent metal so the weld can be ground off smooth after it has cooled.

After welding is completed, allow the part to cool slowly so the metal will be tough and ductile. When cool, the drilled hole for the plunger can be reamed out to remove internal projections at the weld, and the outside can be ground or machined flush in a lathe.

Build Non-Clogging Pump

The American Well Works of Aurora, Illinois has just placed on the market their non-clogging centrifugal pump. The design of this pump marks a new departure in construction and, the company points out, obviates the necessity of screens and their expensive maintenance.

The single blade impeller in the pump is so designed that the stream lines are not separated, but so the stream of fluid is kept in one mass and carried through the pump without being subdivided. By compelling all the liquid and debris to be discharged through a single peripheral passage, there is avoided the possibility of different portions of a single piece of debris being swept into different outlet passages and thereby being hung up within the impeller. This precludes screening sewage or fluid containing other material before pumping.



A view of the new Non-Clogging Pump

Fluids containing stringy matter, mineral matter, animal matter, and vegetable matter such as hair, string, waste, shavings, rags, mud, chips, sand, sludge, wire, debris, slaughter house and fish market refuse, offal, fat, grease, weeds, straw, stable flushings, etc., can be handled successfully.

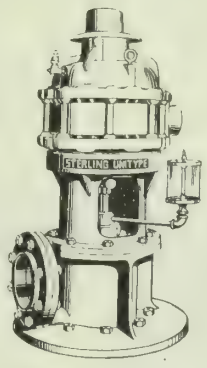
This pump is made in both vertical and horizontal types and is adapted for municipal sewage and general industrial use. Engineering information may be obtained from the engineering department of this company.

Silt Content of Colorado River

The silt content of the Colorado River at Yuma is estimated to average 7,000 parts per million and the total solid burden to amount yearly to 160,000,000 tons.

Sterling Quality CENTRIFUGAL PUMPS

VERTICAL PUMPS for Surface or Pit Pumping. Same construction features as the split case Centrifugal Pump. Sizes—1½ in., 2 in., 3 in., 4 in., 5 in., 6 in., & 8 in. Send for bulletin No. 21.



Sterling Unitype Drive
The Original

Deep Well Turbine Pumps

Made for the following well diams.: 4 in., 6 in., 7 in., 8 in., 10 in., 12 in., 14 in., 16 in., 18 in. and 20 in. Capacities 20 G.P.M. to 4,000 G.P.M. Send for Bulletin No. 16.

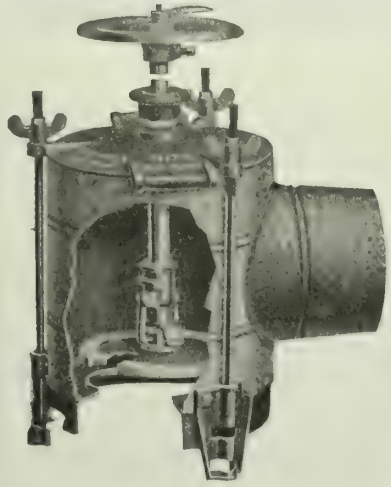
NOTE—The motor drive for this vertical pump interchanges with the deep well Turbine Drive.

Manufactured by

Sterling Pump Works, Inc.

Stockton, California

Member of Western Irrigation Equipment Association.



Martin Portable Hydrant

We manufacture the original line of Irrigation Appliances Outlet Valves, and Cut-off Gates for the definite division of water over the field from Concrete Pipe Lines.

New Catalog Upon Request

Martin Iron Works

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AMONG OUR CONTRIBUTORS

Editorial Jottings About Current and Forthcoming Feature Articles, Dealing With Practical Problems of Hydraulics, and the Men Who Have Written Them

A. K. WARREN

THE IDEA of metropolitan sewage disposal for Los Angeles County has been considered from time to time for many years in the past, but the definite plan and the commencement of construction was accomplished through the efforts of A. K. Warren, the chief engineer of the Los Angeles County Sanitation Districts, who contributes an article in this issue.

During more than twelve years of public service with Los Angeles County Mr. Warren has brought about the construction of several large drainage projects, but it is believed that the metropolitan sewers will be as great benefit to this region as any other public project ever undertaken.

MODERN IRRIGATION publishes in this issue excerpts from the minority report on the San Gabriel River situation submitted by F. E. Bonner, district engineer in the U. S. Forest Service. Mr. Bonner was one of a committee of three appointed to investigate the situation, the other members being F. J. Safley, inspector in the General Land Office, Salt Lake City, and H. D. McGlashan, district engineer of the U. S. Geological Survey. Mr. Bonner is a native of Montana and a graduate of the University of Montana. He entered the U. S. Forest Service in 1909 and has held many important positions in the service. In 1915-16 he was district highway engineer at Missoula, Montana. In 1917 he was assistant engineer in charge of the map and survey division at Washington, D. C. In 1918 he was engineer in charge of the Forest Products Laboratory, Madison, Wisconsin. The following year he was sent to Denver as district engineer, then back to Washington for two years as assistant chief engineer. Since 1922 he has been located in San Francisco as district engineer.

MAJOR W. CARTWRIGHT, who writes on "Equitable Charges for Automatic Sprinkler Connections," was at the time of writing the article on the Board of Fire Underwriters of the Pacific, but has very recently become associated with the Globe Automatic Sprinkler Company of Seattle, Washington.

Major Cartwright has had much experience with automatic sprinklers. Before the World War he was connected with Mather Blatt, an English firm handling several American products. During the war he was in the engineering corps of the British army, was badly gassed, and was sent to America to recuperate. He spent several years in Southern California, where he was connected first with the firm of A. P. Roughton and later with Thomas Haverty Company. Major Cartwright has written a number of articles on various phases of his work, particularly for English publications.

RALPH G. WADSWORTH, assistant engineer with Fred H. Tibbetts, has been connected with the Nevada Irrigation District since its organization. Mr. Wadsworth graduated from the University of California in 1914. From then until the entrance of the United States in the World War he was engaged in reclamation work. During the war he was a captain in the engineering corps, serving both in the United States and in France. Since 1919 he has been with Fred H. Tibbetts, with headquarters in San Francisco.

RAY L. DERBY

RAY L. DERBY, who provided the material for the staff article on the Beverly Hills filtration plant, is connected with the firm of Salisbury, Bradshaw, & Taylor, consulting engineers of Los Angeles.

Mr. Derby is a previous contributor to MODERN IRRIGATION, and needs no introduction. Those who read his very interesting article in the July, 1926, issue will no doubt be glad to learn of the many developments that have taken place since that time. Mr. Derby is a graduate of the University of California, and has specialized in the field of sanitation engineering. His work has been chiefly in connection with water purification.

THE MATERIAL for the article on the progress of the Stevenson arch dam tests was supplied by Fred A. Noetzli, consulting engineer of Los Angeles. Mr. Noetzli received his engineering degree from the Swiss Federal Polytechnic Institute, Zurich, Switzerland, where he was later an instructor. Since 1923 he has specialized in dam construction and has invented improved types of arch and multiple arch dams. He is the author of a number of papers on various phases of arch dam construction.

THE BUYERS' GUIDE TO LEADING SUPPLY SOURCES

Listing Practically All Standard Equipment Used in the Irrigation Country

THE IRRIGATION and hydraulic industry has been greatly handicapped formerly for the lack of some centralized Bureau of Information. Many jobbers, dealers and manufacturer's representatives throughout the irrigation country have considered representation for commercial products of different types but did not know where to locate the names and addresses of the manufacturers of such appliances. The men who do ordering and specifying have not, in many cases, been able to consult an authentic directory of reliable equipment when writing for catalogs or quotations, compiling cost estimates or making out purchase orders. IN SHORT, THERE HAS BEEN NO STANDARD BUYERS GUIDE FOR THE INDUSTRY. It is in order that this need may be met, that MODERN IRRIGATION presents this current "Buyer's Guide to Leading Supply Sources," *corrected monthly*. It will, of course, become more complete as the publication grows in size. The importance to the individual manufacturer of keeping his listings accurate and up-to-the-minute cannot be over-emphasized. Changes and corrections should be forwarded immediately. If any errors or omissions are noted in this month's listings, make sure that such incorrect listing will not appear again by sending your correction or revision by the next return mail.

ADVERTISER	ADDRESS	SEE AD ON PAGE
American Hume Concrete Pipe Co.	Detroit, Mich.	35
American Steel Pipe & Tank Co.	815 W. M. Garland Bldg., Los Angeles	53
Main branches or agencies: American Steel Pipe & Tank Co., 2005 Broadway, near Divisadero, Fresno, Cal.		
American Well Works	Aurora, Ill.	2
Main branches or agencies: Chicago, Ill., First National Bank Bldg.; Milwaukee, Wis., Wisconsin National Bank Bldg.; New York, N. Y., 165 Broadway; Dallas, Tex., Western Indemnity Bldg.; San Francisco, Cal., 635 Mission St.		
Armstrong Manufacturing Co.	Waterloo, Iowa	
Main branches or agencies: Kaufman Co., 129 West 2nd St., Los Angeles, Cal.		
Barber Greene Co.	Aurora, Ill.	3
Bay City Dredge Works	Bay City, Mich.	45
Main branches or agencies: H. W. Moore Equipment Co., Denver, Colo.; J. P. Sherbesman, 560 Geary St., San Francisco, Cal.; Steel Products Corp., El Paso, Texas.		
Bent Concrete Pipe Co.	4th Floor, Grosse Bldg., Los Angeles	
Brooks of California	142 S. La Brea, Los Angeles	51
Browning Manufacturing Company	512 Mission Road, Los Angeles	51
Buckner Manufacturing Company	Fresno, California	51
Byron Jackson Pump Mfg. Co.	Berkeley, California	1
Main branches or agencies: Byron Jackson Pump Mfg. Co., Sharon Bldg., San Francisco, Cal.; Byron Jackson Pump Mfg. Co., 412 S. San Pedro St., Los Angeles, Cal.		
California Associated Concrete Pipe Manufacturers	2146 Merced St., Fresno, Cal.	49
California Corrugated Culvert Co.	411 Parker St., Berkeley, California	Outside Bk. Cvr.
Main branches or agencies: California Corrugated Culvert Company, 409 LeRoy St., Los Angeles, Cal.; California Corrugated Culvert Company, 745 Lake St., Reno, Nevada; California Corrugated Culvert Company, 1628 Floradora Ave., Fresno, Cal.; California Corrugated Culvert Company, 3422 Herbert St., San Diego, Cal.; California Corrugated Culvert Company, 1625 38th St., Sacramento, Cal.; Western Metal Mfg. Company, El Paso, Texas; Western Metal Mfg. Company, Houston, Texas.		
Caterpillar Tractor Co.	San Leandro, California and Peoria, Ill.	4
Commercial Iron Works	2424 Porter St., Los Angeles, Cal.	46
Cook, A. D., Inc.	Lawrenceburg, Indiana	36
Main branches or agencies: California Pump & Well Supply Co., Los Angeles; Pump Equipment Co., Seattle; Casper Supply Co., Casper, Wyoming; P. D. Whitaker Co., Denver.		
Crown Bitumens Corporation	315 Montgomery St., San Francisco, Cal.	47
Dearborn Chemical Company	310 S. Michigan Ave., Chicago; 299 Broadway, New York; 909 Santa Fe Avenue, Los Angeles	41
Everlasting Paint & Sales Co.	704 Sun Finance Bldg., Los Angeles	
Fairbanks, Morse & Company	900 S. Wabash Ave., Chicago, Ill.	20
Main branches or agencies: Fairbanks, Morse & Co., Box 390 Arcade Sta., Los Angeles, Cal.; Fairbanks, Morse & Co., Spear and Harrison Sts., San Francisco, Cal.		
Great Western Meter Company	1290 Powell St., Oakland, Cal.	52
Hadden Automatic Sprinkler Co.	1101 Meridian, Alhambra, Cal. Los Angeles Phone GArfield 9329.	51
Albert E. Harris	5083 Aldama, Los Angeles	51
Hill Hubbell & Co.	115 Davis St., San Francisco, Calif.	37
Hill Sprinkler Co.	1406 W. Slauson Ave., Los Angeles	51
Hotel Plaza	Post St. at Stockton, San Francisco, Cal.	56
James Jones Company	201 LeRoy Street, Los Angeles	35
Kelley-Connell Co.	1330 Second St., Berkeley, Cal.	21
Kimball, Frank J. Company	Box 154, Arcade Sta., Los Angeles, Calif.	52
Main branches or agencies: F. M. Buckingham, 334 W. Moreland St., Phoenix, Ariz., Frank J. Kimball Co., 389 Santa Clara St., San Jose, Cal.; Frank J. Kimball Co., 2123 Inyo St., Fresno, Cal.		
Layne & Bowler Corp.	900 Santa Fe Ave., Los Angeles, Cal.	47
Lacy Manufacturing Co.	601 Washington Bldg., Los Angeles, Cal.	41
Lippincott and Stewart	P. O. Box 502, Sta. C, Los Angeles	51
Los Angeles Mfg. Company	2500 E. 23rd St., Los Angeles, Cal.	32
Luitwieler Pumping Engine Co.	707 No. Main St., L. A.	37
Luxol Chemical Products Co.	1238 San Fernando Road, Los Angeles	40
Martin Iron Works	1222 E. 28th St., Box 757, Arcade Sta., Los Angeles, Calif.	57
Masterson, Jos. A. & Co.	1822 S. Hope Street, Los Angeles	40
McWane Cast Iron Pipe Co.	Birmingham, Alabama; 422 Central Bldg., Los Angeles	33
Montague Pipe & Steel Co.	Hobart Building, San Francisco, Cal.	56
Main branches or agencies: Montague Pipe & Steel Co., 202 Market St., Oakland, Cal.		
Northwest Engineering Co.	1727 Steger Bldg., Chicago, Ill.	Inside Front Cover
Main branches or agencies: 23 Main St., San Francisco; 438 E. Third St., Los Angeles; 149 W. Second St., South, Salt Lake City, Utah; 306 So. Seventh Ave., Phoenix, Ariz.		
Owensboro Ditcher & Grader Co.	140 No. Los Angeles St., L. A.; 131 Kansas St., S. F.	52
Pacific Pipe Company	207 Folsom St., San Francisco, Cal.	53
Pacific Pump Works Phone Midland 3101	350 Bickett St., Huntington Park, Los Angeles, Cal.	55
Pacific States Cast Iron Pipe Co.	Provo, Utah; 422 Central Bldg., Los Angeles	33
Pacific Tank & Pipe Co.	322 Market St., San Francisco, Cal.	46
Parsons Company	Newton, Iowa	4
Main branches or agencies: C. C. Sixbey, 677 Chamber of Commerce Building, Los Angeles; Garfield and Company, Hearst Building, San Francisco.		
Peerless Pump Co.	1916 E. 67th St., Los Angeles, Cal.	44
Philbrook Spring Pipe Clamp Co.	621 E. 12th St., Los Angeles, Cal.	36
Pomona Mfg. Company	Pomona, Cal.	6
Price, G. W. Pump & Engine Company	1350 Folsom St., San Francisco, Cal.	43
Main branches or agencies: Coast Electric Service, San Jose, Cal.; Sherman Electric Co., Corning, Cal.; Woodlake Hardware Co., Woodlake, Cal.; California Mechanical and Electrical Co., Sacramento, Cal.; Simonds Machinery Co., San Francisco, Cal.; M. W. Lavender, Orosi, Calif.; Sanger Plumbing House, Sanger, Cal.; Byers & Lighty, Dinuba, Cal.		
Randall Control & Hydrometric Corp.	1014 E. 9th St., Los Angeles, Cal.	55
Main branches or agencies: Guy L. Warden, District Engineer, 589 Chamber of Commerce Bldg., Los Angeles, Cal.		
Roscoe Moss Company	4360 Worth St., Los Angeles, Cal.	35
Ruth Dredger Sales Corp.	Boyle & Slauson Ave., Los Angeles, Cal.	49
Silverberg, Irvin, & Co.	541 Van Ness Avenue, San Francisco	40
Smith Emery Co.	245 S. Los Angeles St., Los Angeles	44
Snow Mfg. Company	2437 E. 24th St., Los Angeles, Cal.	52
Southern Counties Gas Co.	810 So. Flower St., L. A.	
Sparling, R. W.	945 N. Main St., Los Angeles, Cal.	55
Sterling Pump Works	646 S. California St., Stockton, Cal.	57
Main branches or agencies: Sterling Pump Works, Inc., Delano, Cal.; Sterling Pump Works, Inc., 1209 Broadway, Fresno, Cal.		
Clarence H. Thomas	1147 El Serrano, Los Angeles	51
Thompson Manufacturing Company	2251 E. Seventh, Los Angeles	51
U. S. Cast Iron Pipe & Foundry Co.	Burlington, N. J.	31
Main branches or agencies: 3rd and Market Streets, San Francisco, Cal.		
H. E. J. Vacher, Manufacturer	212 N. Quarantina, Santa Barbara	51
Vindicator Company	P. O. Box 1055, Glendale, Cal.	51
Wallace & Tiernan	Newark, New Jersey	39
Main branches or agencies: I. W. Hellman Bldg., Los Angeles; 57 Post St., San Francisco.		
Western Concrete Pipe Company	P. O. Box 355, Los Angeles	24
Western Pipe & Steel Co.	5717 Santa Fe Ave., Los Angeles, Cal.	43
Main branches or agencies: Phoenix Plant, 611 Dunlap Ave., Phoenix, Arizona; Taft Plant, Corner Supply Row and Sixth St., Taft, Cal.; Fresno Plant, 1815 Cherry Avenue, Fresno, Calif.; South San Francisco Plant, Butler Road, South San Francisco, Calif.		
Westinghouse Electric & Mfg. Co.	420 S. San Pedro St., Los Angeles, Cal.	
Main branches or agencies: Westinghouse Electric & Mfg. Co., First National Bank Bldg., San Francisco, Cal.; Westinghouse Electric & Mfg. Co., J. & Mariposa Sts., Fresno, Cal.; Westinghouse Electric & Mfg. Co., 412 Luhrs Bldg., Phoenix, Ariz.; Westinghouse Electric & Mfg. Co., Mills Bldg., El Paso, Texas; Westinghouse Electric & Mfg. Co., 2415 El Capitan Ave., San Diego, Cal.		
Woodin & Little	33-41 Fremont St., San Francisco, Calif.	49
Woolwine Metal Products Co.	8th St. and Santa Fe Ave., Los Angeles	21

THE PRINCIPAL SOURCES FOR GENERAL EQUIPMENT LINES USED IN THE IRRIGATION AND HYDRAULIC INDUSTRIES

AIR COMPRESSORS
Fairbanks, Morse & Co.
Sterling Pump Works
Woodin & Little

AIR LIFTS
Kimball, Frank J. Co.
Woodin & Little

BEARINGS
Jos. A. Masterson & Co.
Irvin Silverberg & Co.

BOILERS
Los Angeles Manufacturing Co.
Montague Pipe & Steel Co.
Western Pipe & Steel Co.

BRASS GOODS
James Jones Co.

BRASS PIPE FITTINGS
James Jones Co.

BUTTERFLY VALVES
Commercial Iron Works
Kelley-Connell Co.
Woodin & Little

CANAL LINING
Crown Bitumens Corp.

CASING, WATER WELL
American Steel Pipe & Tank Co.
Los Angeles Manufacturing Co.
Montague Pipe and Steel Co.
Western Pipe & Steel Co.

CHEMICALS
Dearborn Chemical Co.
Luxol Chemical Products Co.

CAST IRON PIPE
McWane Cast Iron Pipe Co.
Pacific States Cast Iron Pipe Co.
U. S. Cast Iron Pipe Co.

CHECK VALVES
Byron Jackson Pump Mfg. Co.
Commercial Iron Works
Kelley-Connell Co.
Woodin & Little

CONCRETE MIXERS
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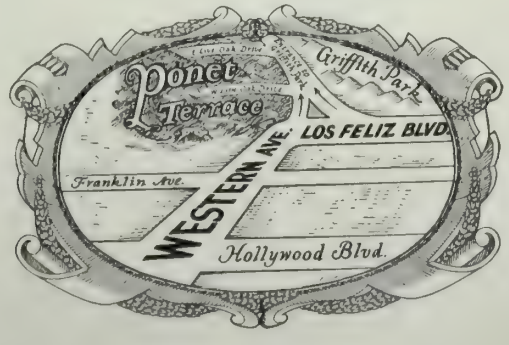

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MODERN Irrigation

The Magazine of Applied Hydraulics

Vol. III FEBRUARY, 1927 No. 2

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HORSE MESA DAM UNDER CONSTRUCTION NEAR PHOENIX, ARIZONA

In This Issue—

Salt River Valley Makes a Profit on Its $25,000,000 Investment

The Pumping Plant—Heart of the Irrigation System

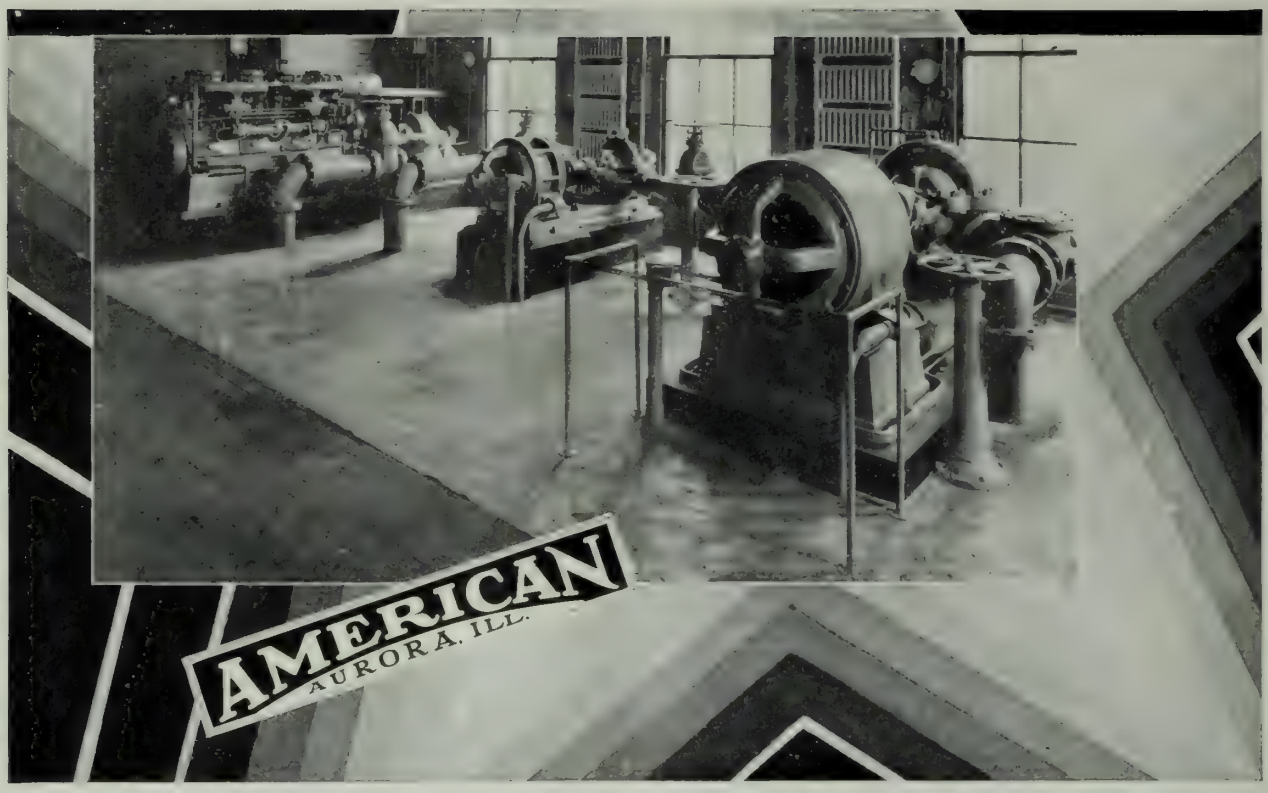
$334,000,000 Is Involved In California's Water Plan

How Los Angeles Solved Its Latest Sewage Disposal Problem

Legislation as an Aid in California Districts' Fiscal Troubles

Per Copy: 20c Published at 626 SO. SPRING STREET, Los Angeles By the Year $2

An Organized Voice for the Forces of Agriculture and Industry Which are Primarily Dependent Upon Irrigation



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All these motors are provided with Sundh automatic starters. This installation was made in 1924 and replaced the old steam-driven station that had been in service for a considerable length of time. City engineers should be interested in the economies effected. "American" engineers will be glad to furnish details.

THE AMERICAN WELL WORKS

General Offices AURORA, ILLINOIS *and Factory*

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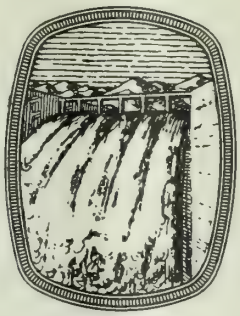
"Western Waterworks" Begins on Page 25

CHARLES HOWARD PAUL

Widely known consulting engineer, who is acting in an advisory capacity in the design and construction of the San Gabriel River dam, Los Angeles County, California. Mr. Paul was for many years chief engineer for the Miami Conservancy District, Ohio, and is now retained by the Los Angeles Flood Control District as consultant. The world's highest dam, located at Arrowrock, Idaho, was designed and constructed under the personal direction of Mr. Paul, and is but one of the many monuments to his engineering genius.

MODERN Irrigation
The Magazine of Applied Hydraulics



Volume III FEBRUARY, 1927 Number 2

The Progress *of* Irrigation

BUFFETED about from pillar to post through the legislative chambers of the nation, the Swing-Johnson bill for the construction of a dam at Boulder Canyon on the Colorado River, with edges slightly frayed, was still in the ring as this issue went to the printer. Opinions vary on the possibility of a vote on this vital piece of legislation at this session of Congress, but there can be little doubt in the minds of those who have followed the fortunes of the bill at Washington that selfish interests of the sister states have completely overshadowed the major issues involved.

A vote on the bill is blocked at this writing because of the failure of the House Rules Committee to give the measure the legislative right of way. For some reason or other the feeling seemed to be that the prospects for the bill are brighter since mid-February when Speaker Longworth said a good word for the bill when its supporters called on him in an endeavor to get action, although the Speaker has no power to force action on the part of the Rules Committee.

Chairman Smith of the Irrigation Committee which reported the bill told Speaker Longworth that the recent withdrawal of Utah from the Colorado River compact was one of the chief reasons why the Rules Committee had not granted the measure preferred status. Smith is authority for the statement that Governor Dern of Utah has indicated that that state may rescind its action and again ratify the pact. Governor Dern is quoted by Smith as saying that the chief objection of his state would be removed by the adoption of the Colter amendment, designed to put water distribution features under the terms of the compact. Smith said that this amendment will be accepted by supporters of the bill.

Discussion of the impasse over the bill might be carried on at greater length, but with only one conclusion to be drawn: namely, that petty politics and sectional jealousies are holding up a development that the nation can ill-afford to delay much longer.

Washington dispatches have carried another item of news of especial interest to western agriculturists in the passage by the Senate of the McNary-Haugen bill, the higher house reversing its position of less than a year ago on the measure. The measure has been transmitted to the House of Representatives and probably will have been voted on by that body be-

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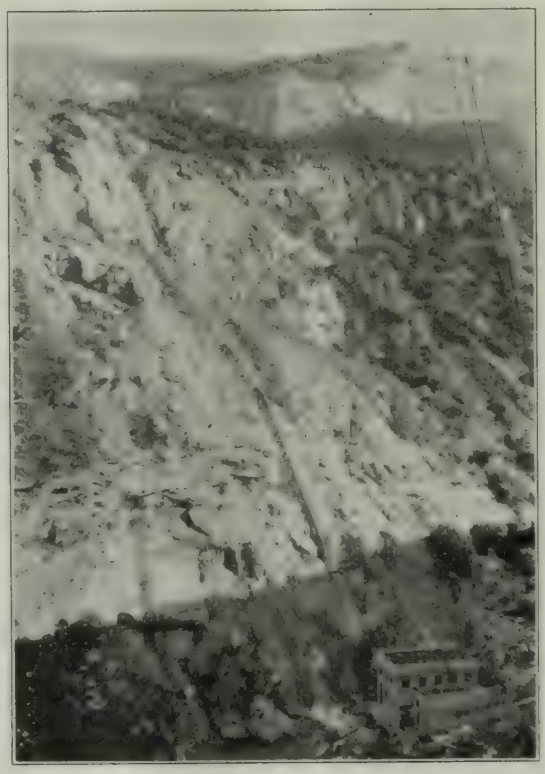
fore this issue is in the reader's hands. Positive action is anticipated by the lower house, but there is considerable uncertainty as to what the attitude of President Coolidge will be when the bill comes to him for his signature. In the event of his veto, it would be admittedly impossible for either house to muster the necessary two-thirds majority to pass it over a veto.

This measure, first introduced and defeated in 1924, has been earnestly pressed on Congress and the country on the plea that agriculture is in a fundamentally unsound and distressed condition, unable to recover by its own efforts, and that the national welfare requires that it have legislative assistance. With the continuance of agitation the various farm organizations which have strength over the country have gradually concentrated their support on the measure. This has had the effect of causing many persons with doubts about such legislation to at least withhold opposition, due to their faith in the judgment of these supporting farm bodies.



PENSTOCK FOR KINGS RIVER POWER PLANT
The completion of the plant by the San Joaquin Light and Power Corporation marks the first attempt to harness the water of this California stream. The line is considered a feat of modern engineering and demonstrates that the tendency of power development is towards greater heads with less water.

The opposition to the measure which thus far has defeated it does not deny that the state of agriculture is in many respects unsatisfactory, but holds that the conditions complained of cannot be remedied by legislation, and regards this particular plan as artificial and impracticable.

The advocates of the several McNary-Haugen bills have denied that the object was price fixing, urging that they sought only to establish and maintain a proper parity between farm products and other commodities and services.

"The aim of all the McNary-Haugen bills," declares the February Bulletin of the National City Bank of New York, "has been to correct the unfair relations existing since 1920 between the prices of farm products and the prices of what the farmers have to buy. It is well known that these price-relations have changed from what they were before the war and that the change has been against the farmer. It also is well known that the change has been due to the general rise of wages during and since the war. This rise has affected agriculture along with the other industries, but inasmuch as wages are a smaller factor in the value of farm products than in the value of most other products the latter has been established at least temporarily upon a relatively higher basis than the former.

"All of the McNary-Haugen bills," the bulletin continues, "have sought to remedy this condition by establishing a Federal Farm Board to exercise certain extraordinary powers in the marketing of farm products. To quote the Committee report on the bill, the Board is to 'aid in the orderly marketing and in the control and disposition of the surplus of agricultural commodities.' It is given practically unlimited authority within its financial resources to 'assist in removing or withholding or disposing of the surplus' of the commodities named, and to levy what is called an 'equalization fee' upon all producers of any commodity in which it is operating, for the purpose of paying 'losses, costs and charges' incurred in such operations. An appropriation of $250,000,000 is provided by the bill to start the Board in business."

There are good reasons for believing that the state of agriculture is not as bad as represented by the advocates of this bill. The position of agriculture is inherently sound, for the population of the world is always growing and soon catches up with any expansion which temporarily outruns requirements. It has done so repeatedly and there is no reason for believing that it will not continue to do so.

"Western Waterworks" Begins on Page 25

Solution of Financial Problems a Requisite to Successful Land Development

Better Financing of Reclamation and Irrigation Bonds Should Receive Serious Thought in California; Change in Law Needed

By WILLLIAM DURBROW*

THE United States Government has used the word "reclamation" in designating its Department which is primarily concerned in the putting of water upon desert or arid lands in order that they may become productive. On the other hand, we here in California have used the word "reclamation" to designate certain districts having to do primarily with the taking of water off of the land, either through drainage channels or by levee protection. In contra-distinction to this, we use the word irrigation to designate putting water on the land. In a broader sense of the word, reclamation covers both of these processes by which lands at one time unproductive are brought into productivity.

When this subject was first handed to me for discussion my first thought was that the narrow meaning of reclamation, as we apply it here in California to certain districts having to do with the drainage or levee protection of lands, was intended. I was glad to find, however, that instead of this, the broader term for reclamation was intended for my subject—involving as it does both the putting on of water as well as the taking of it off.

For the purpose of the present discussion, the primary consideration is that both of these processes require the expenditure of money. In the expenditure of this money—whether it be done wisely or foolishly—depends largely the success and well being of the multitude of farmers of our State depending upon the productivity of our soils for their livelihood.

Three Kinds of Financing

There are three broad divisions into which, for the purpose of this discussion, may be thrown the financing of the reclamation of our lands:—*first,* Government financing; *second,* reclamation district financing; *thirdly,* irrigation district financing. This leaves out of the consideration, indivdual or corporation financing with which we are not here concerned.

Under the heading of Government financing, we have, in the first place, the expenditures of United States Government authorized by Congress for the protection and improvement of our navigable streams. These expenditures of the national Government have been of enormous value in aiding the farmers of our overflowed valley regions to keep the rivers within definite channels and in carrying out a great scheme, which, when

WILLIAM DURBROW

completed, will give adequate protection to lands that are protected by levees along our streams. This method of financing involves simply an appropriation from Congress with no provision for repayment out of the income from the land.

A Doubtful Benefit

There is now before Congress and the State Legislature a plan for a more complete co-ordination with the landowners, by which the Government and the State each pay one-third of the cost of the work already done or to be done in the control of our two main rivers, and it is to be greatly hoped that these plans will be consummated and relief given to highly productive sections of our State, which are today staggering under a greater burden than it appears possible, in some cases, for them to carry.

Also under the heading of Government financing, we have the expenditures made through the Reclamation Service. These expenditures have been made largely with interest-free money—the Government contracting directly with the owners of land within the projects for a subdivision of the land owned by such landowners into small units and the paying back of the cost of construction of the system built by the Service over a long period of years. This has not been an important item in financing the reclamation of lands in California. There has been much discussion and comment upon the success or failure of this form of financing. In a general way it may be said that the financing of irrigation districts—springing as it has from the economic need for such irrigation—has been more successful, has met charges more promptly and has been productive of a more rapid increase in colonization than has the more or less forced development that has come about through the development of arid regions through the operation of the Reclamation Act, sponsored too often by the sectional desire for the expenditure of government money.

I venture the suggestion that the funds made available by the Reclamation Act would have been of greater economic importance to the Western States had the government—instead of dealing directly with the landowners and later with the settler—required the organization of districts financed through the ordinary method of irrigation district financing for the distribution of water and then proceeded to do the big things that economically, for the landowner, were impossible. This would involve the building of dams, the equalization of stream flows and the transportation of water over great distances to their place of use.

Government Subsidy

There have been projects in the past—and they are becoming more numerous as the cheaper waters of the West are being used up,—which are impossible from a financial standpoint when related back to the value of farm products, but

(*Continued on Page 44*)

*A paper read at the annual meeting of the American Society of Agricutural Engineers, San Francisco, December, 1926

"Western Waterworks" Begins on Page 25

How a $25,000,000 Investment in Salt River Valley is Paying Out for the Farmer

This Same Amount is Approximately the Annual Revenue from Crops on Arizona Project; Horse Mesa Dam is Latest Addition

By H. B. WATKINS

THE story of the development of irrigation in the Salt River Valley of Arizona reads like romance. Historically, irrigation began some half century ago; that is, modern irrigation, because the early settlers who built their crude brush and stone dams on the rivers and dug canals followed rather closely the canals which had been dug by that prehistoric race of people who inhabited this southwestern country in times so long past that even a conjecture as to the period of their existence is a matter of dispute among archaeologists.

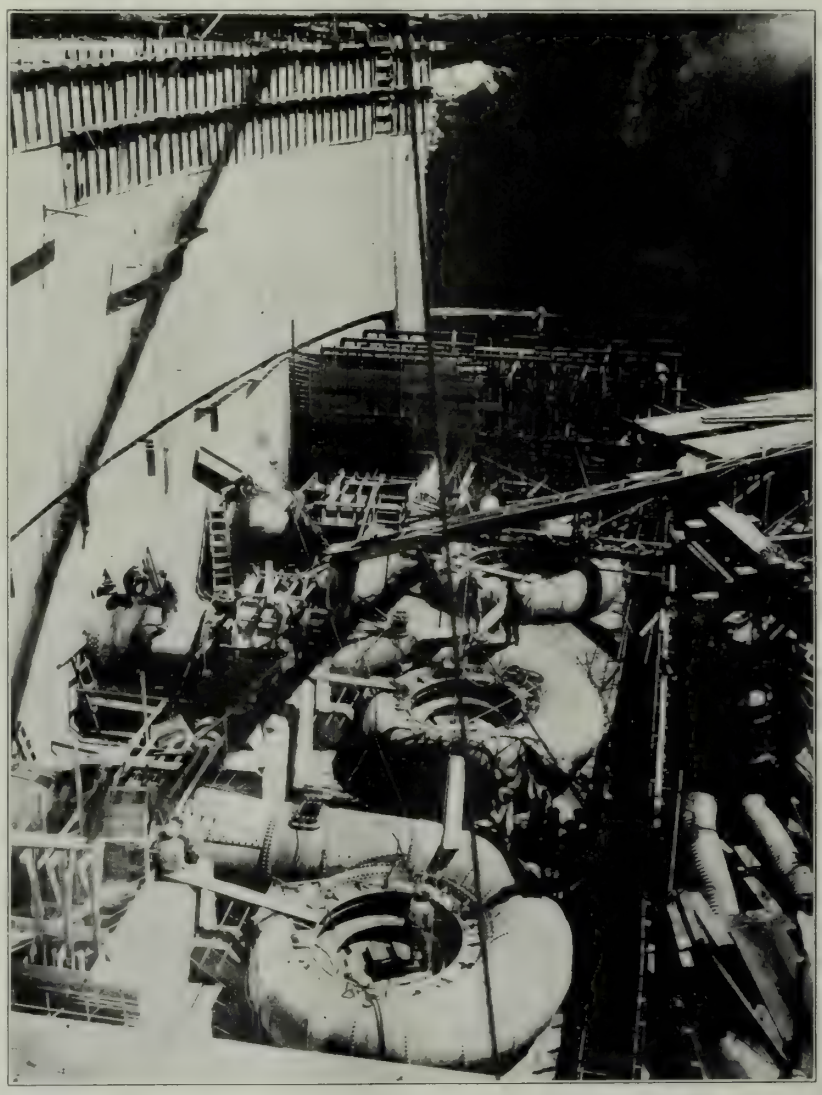
History of Progress

While acreage was extended gradually and farmers were in most cases prosperous, the real development of agriculture in Arizona began with the building of the Roosevelt dam by the U. S. Reclamation Service. This dam was begun in 1906 and finished in 1911. When the government undertook this project there were about 150,000 acres of land under irrigation and some fifty independent canal systems. The reclamation project as finally carried out by the government consisted not only of the building of Roosevelt Dam, but amalgamating all of the small canal systems into one association of land owners. The doctrine of inseparability of land and water was adopted as an essential part of the plan and each acre of land carried with it as a right, one share in the association. Thus, there was eliminated once and forever all negotiations in water stock with its consequent litigation and friction.

Local History

The U. S. Reclamation Service operated the project from the time that it was taken over in 1906 until 1917 when it was turned over to the Salt River Valley Water Users Association. This organization, with an executive body consisting of a board of governors and a legislative body consisting of a counsel, employs a professional engineer as superintendent and project manager.

The progress which has been made in irrigation and in the development of hydro-electric power, during the ten years which the association managed the project, has made this one of the oustanding irrigation projects in the United States.



VIEW OF POWER HOUSE
Scroll cases, Horse Mesa Power Plant. The three 15,000 H. P. units are shown in place.

Irrigated Acreage

There has been a gradual increase in acreage, from the 150,000 acres when the Roosevelt Dam was begun, to the present time when 240,000 acres are irrigated directly from the original project. Indirectly and through cooperation with the project there has been a considerable increase in acreage. At the present writing about 350,000 acres of land are under irrigation in Maricopa County. Within a very short time this will be increased some sixty to seventy thousand acres with a further increase in possibly a twelve months period. In all there is estimated to be approximately 700,000 acres of land which it is feasible to irrigate mostly by gravity water.

Roosevelt Conservation District

The Roosevelt Conservation District comprises about 40,000 acres of land immediately east of the Salt River Project. While this is a separate project, it is through cooperation with the Salt River Valley Water Users Association that this development has been made possible. Under the Salt River Project there was a considerable

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loss of water from seepage in the canals. This loss was very carefully checked and the new project was allowed to line with cement two canals, and the saving of water was in turn transferred to the new project. Supplementing this water is the water pumped from shallow wells by power obtained from the Salt River Valley Water Users Association.

Another project to the west of the Salt River Project is now in process of development. Through a cooperative agreement, this new project will be permitted to purchase water which is pumped from the underground supply of the older project. This is part of a plan of drainage to prevent water logging of the land. Some of the water pumped from these drainage wells is mixed with the gravity water used for irrigating on the original project. The drainage system of the Salt River Project is one of the outstanding features of this development. By this system the project is insured against the dangers which have proved so costly in many of the older irrigation projects.

Still another project to the north of the Salt River Valley is now under consideration. This contemplates the irrigation of about 80,000 acres of land in what is known as Paradise Valley. Plans for this, however, are incomplete.

These projects which have so far been mentioned are more or less cooperative with the Salt River Project.

New Dam on Agua Fria

A new project which will be entirely separate from the older project is that of the Beardsley Land Company, known officially as the Maricopa County Municipal Water Conservation District No. 1. A dam is being built on the Agua Eria River and this will be completed some time during 1927. About 40,000 acres will be irrigated under this project.

Along the Gila River below the Gillespie Dam there is an area of land comprising some 80,000 acres which will be brought under irrigation in the near future. This will complete the plans originally made when the Gillespie Dam was built and will thus add a large area of land to that which is already under irrigation in the Salt and Gila Valleys in Maricopa County.

A large part of the success of the Salt River Project has been due to the development of hydro-electric power. The Mormon Flat Dam was built on the Salt River below the Roosevelt Dam primarily for the purpose of storing water released from the Roosevelt Dam at times when the water was not needed for irrigation. This has resulted in an

(*Continued on Page 27*)

HORSE MESA DAM AND POWER HOUSE

At left are seen three 24-inch discharge pipes from pumps dewatering pit. In center are seen the three eight-foot penstocks in place ready for pouring concrete around them. Immediately to right and above right hand penstock is seen the entrance to the flume used to by-pass the river. The lake formed by the gravel and earth cofferdam is shown in the middle distance. At this end of the pond is seen one of the three 2-yard clam-shell bucket derricks and two scows used in carrying gravel. Two of these clam-shells dig gravel from the river bed and load it into the scows which are towed to the dam-site by two marine tugs brought overland from San Francisco. One of these is seen in the picture headed upstream. The third derrick at the dam unloads the scows into a small bin which discharges into self-dumping cars. These are elevated along a steep inclined trestle, double tracked, to the mixing plant 300 feet above the river. The foot of the incline is shown in this picture. The 20-inch Insley chute, with two counter-weights is shown, suspended from a skyline which spans the canyon from cliff to cliff at an elevation of more than 700 feet above stream bed.

HORSE MESA DAM SHOWING POWER HOUSE

The power house is completely poured and o-gee section of spillway poured to within eight feet of spillway crest. Taintor gates 27 feet wide and 23 feet high will close the spillway. At the height shown, the dam is 80 feet above water level on the down-stream side. One of the tugs and five of the gravel scows are shown at this end of the lake near the derrick barge. Draft tube outlets of power plant are submerged.

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Big Projects Are Involved in Bailey's Plan for Development of California Waters

Recommendations for Sacramento and San Joaquin Valleys Calls for Expenditure of $334,000,000; Committee Would Administer Plan

By PAUL BAILEY, State Engineer

Extracts from a Report to the California Legislature of 1927

THIS report presents an engineering plan whereby, through coordination of effort, those sections deficient in local supply may enjoy adequate water for agricultural and all other purposes. The new supplies for the deficient areas would be taken from regions of surplus after providing for their complete development. This plan is presented as the one containing the fewest difficulties in the attainment of the desired accomplishments. While only the major areas were considered in formulating the plan, any policy that may result should extend to all parts of the state alike.

So extensive is the area, so many and varied are the interests, and so great are the expenditures involved in this plan that the usual method of procedure is impracticable. The economic, financial, legal and political problems relating to its execution are so complex and far reaching that they should be the subject of careful deliberation. The broad values and public advantages of the plan should be weighed with the costs and difficulties. Methods of execution, of operation and of financing should be considered along with the extent to which costs should be distributed. In view of the intricate nature of these problems and their momentous bearing upon the future of California, the Division and its advisors earnestly recommend that a committee representative of all those concerned in the development of the water resources of California, including national and state offices, be appointed solely for the purpose of determining first, the practicability of carrying out this plan, and second, if found to be practicable, to recommend a method of procedure.

Sacramento Valley Plan

The units of a coordinated construction program for the Sacramento Valley comprise a high dam near Kennett on the Upper Sacramento River, one on the Feather River near Oroville, one on the Yuba River near Smartsville, one on the Bear River near the state highway crossing, and one on the American River near Folsom. The Trinity River diversion would introduce a new supply from the Klamath River system into the Sacramento Valley. These would each be integral parts of the comprehensive plan for ultimate development, could be constructed progressively, and would provide sufficient water to meet all the increase in demands of navigation, of salt water control and of conservation during the next half century if operated in accordance with the plan herein presented. The reservoir capacities of these units are adequate to reduce floods and, on those streams on which placer gravels exist, to restrain mining debris for many years without interference with their conservation values. Also a large amount of electric power could be generated at the dams.

In preparing this coordinated plan, special attention has been placed upon devising a safe procedure for the use of reservoirs for flood control without sacrifice of their conservation values.

Since power is the most readily marketable product of the reservoir system, the plan proposes to operate these reservoirs for the first period of years in a manner that will produce the greatest revenue from power. The block of power generated at these reservoirs should produce a substantial income if successfully marketed. The output is large. Including the Trinity River diversion, it is about equal to the present total production of power in northern California. To sell this large block of power will require skill in laying out the construction program and the complete cooperation of every marketing agency. Without this cooperation, a program as herein described would be wholly impracticable. With this cooperation, the sale of power could do much toward carrying the construction costs.

Power Features in Mind

In proposing to operate this system of reservoirs for the first period of years to obtain the greater power revenue, the other benefits to be derived from their construction would not be neglected. Through the program of reservoir operation devised by these investigations, the flood control values could be secured without material interference with the generation of power. The water from the tail-race of power plants would be ample for navigation, irrigation and salt water control for a long time. On the streams on which placer gravels exist, the accumulation of mining debris in the reservoirs, in being slow and not affecting the power drop at the dam, would not materially affect the power output.

At the end of the period of operation for greatest power revenue, the system of operating the reservoirs would be gradually changed to that producing the largest flow regulated for irrigation purposes. This change in the method of operation would about double the summer flow yield of the reservoirs. Power could still be generated, but being largely seasonal power, could only be marketed in part. Following this scheme, the summer flow in the Sacramento River could be adequately maintained for all purposes in the face of increasing diversions for the next half century.

The realization of such a program would be of inestimable value to navigation, salt water control, mining, flood control, irrigation and farming in general. It would secure for the present day the great advantages of a substantial summer flow in the Sacramento River for navigation, the advantages of salt water control in the delta region, the rejuvenation of hydraulic placer mining, and a substantial reduction in the flood flows. None of these could be obtained in nearly such full measure for years to come except through a coordinated program of development. These advantages all have such real and substantial value that earnest consideration should be given to the recommendations contained in this report.

The plan does not include the construction of canals for distributing the water developed by these reservoirs, although studies have been made of alternate layouts. In general, the public advantage of following one particular scheme of canal construction was not found to be large. It is believed that this part of the program can be most effectively carried out by local effort as necessity arises. Therefore, the plan for the Sacramento Valley is confined to the production of a full supply of water in the stream channels in a way that will

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secure the maximum public service from these waters at the least expense.

The San Joaquin Valley

The perfection of supplies in the northern half of the San Joaquin Valley concerns principally the preparation of suitable economic plans for constructing storage reservoirs to hold over winter and spring flood waters for summer use. This has already been done or is now in progress on most of the projects in the northern half of the valley. In the southern half, however, the perfection of present inadequate supplies necessitates the importation of large amounts of new water that presents problems insurmountable to local effort. Here more than four-fifths of the mean flow of the streams is now in use although no reservoirs have been constructed. The irregular diversions from the rivers are supplemented by pumping from underground sources on one-third of the irrigated lands while on another third the entire supply is derived from wells.

Favored with large areas overlying excellent supplies of underground water, the southern San Joaquin Valley has enjoyed an attractive source of water easy for individuals to develop. So encouraged, extensive communities dependent upon irrigated agriculture have come into being. Their wealth is reflected in their assessed valuation that shows a greater investment in rural improvements than any other section of the state excepting properties adjacent to our larger cities.

Although intensive development is in progress, there is still much good land in these communities without an adequate water supply. Nevertheless, so extensive is the use of underground water that the water plane is receding in many places. Experience is demonstrating that these underground supplies are not sufficient for the full development of the overlying lands so that at some point in the progress of expansion, the draft from the underground waters must exceed their average supply.

There are now about half a million acres in the southern San Joaquin Valley supporting prosperous communities, that are either overdrawing their underground supplies or are appoaching this condition. These areas are constantly growing larger. Their available surface supplies are already put to full use. Therefore, new water from some outside source is essential for continued growth and prosperity. Without it, the level of the underground waters upon which the southern half of the valley is so dependent, must permanently recede over extending areas until the profit in farming is entirely consumed in pumping the irrigation supplies to the ground surface.

Estimated Cost of Water Development in Sacramento and San Joaquin Valleys Is $334,000,000

THE probable costs of the units of the coordinated plan in the Sacramento Valley, including spillways, gates, sluices, tunnels, conduits and power plants required are:

Unit	Stream	Height of dam, feet	Capacity of reservoir, acre-feet	Total cost
Kennett Reservoir	Upper Sacramento	420	2,900,000	$80,000,000
Oroville Reservoir	Feather	300	345,000	35,000,000
Narrows Reservoir	Yuba	435	445,000	30,000,000
Parker Reservoir	Bear	250	100,000	6,000,000
Folsom Reservoir	American	190	307,000	11,000,000
Fairview Reservoir	Trinity	370	1,400,000	*46,000,000
Total				$208,000,000

*Includes cost of completely developing the power drop from the Fairview reservoir on the Trinity River to the Sacramento River.

The probable costs of the reservoirs of the coordinated plan in the southern San Joaquin Valley that will yield, in conjunction with the ground-water development already existent, completely regulated supplies of irrigation water, control floods to one-half their maximum values, and develop incidental hydro-electric power to the greatest economic extent, are:

Unit	Stream	Height of dam, feet	Capacity of reservoir, acre-feet	Total cost
Temperance Flat Reservoir	Upper San Joaquin	595	1,100,000	$51,000,000
Pine Flat Reservoir	Kings River	450	1,400,000	35,000,000
Isabella Reservoir	Kern River	250	1,100,000	40,000,000
Bakersfield Reservoir	Kern River	140	200,000	
Total				$126,000,000

The probable cost of the first units of the co-ordinated plan for introducing a new supply from the Sacramento into the southern San Joaquin Valley, that will have a capacity of three thousand second-feet, the equivalent supply for 450,000 acres of new land, is:

Item	Cost
Dams and pumping plants on San Joaquin River complete with levees along river banks	$13,000,000
Canals extending southerly from Friant on upper San Joaquin River to Kings River and from Kings River southerly to near Earlimart	11,000,000
Total	$24,000,000

A Knotty Problem

The complication in the approach to exhaustion of the water supply in the southern San Joaquin Valley is of statewide concern for there is no simple means of relief. There is no way to stop the sinking of new wells. All the overlying lands have the legal right to pump from the underground sources if they choose. The construction of storage reservoirs on local streams would help temporarily but little new water would be created thereby because four-fifths of the mean flow in the streams is already in use. The principal value of storage reservoirs would be in effecting a controlled supply. Unused water in other parts of the San Joaquin Valley is not available for the southern half, because there are areas of deficient supply close at hand to the few regions of surplus.

The valley as a whole has little more than half enough water for its future needs. Therefore, a permanent solution to the water problem of the southern San Joaquin Valley can only be attained by the importation of a large supply from some outside source.

The most accessible region of surplus is the Sacramento and upper Trinity drainage basins. Here is ample water, taken with the San Joaquin Valley streams, for the full development of both valleys. The complication and large cost of transporting the surplus waters of the Sacramento several hundred miles to the southern San Joaquin Valley, requires a comprehensive treatment of the problem. The coordinated plan proposes to correlate the conveyance of a new supply into the southern San Joaquin Valley with the development of water for

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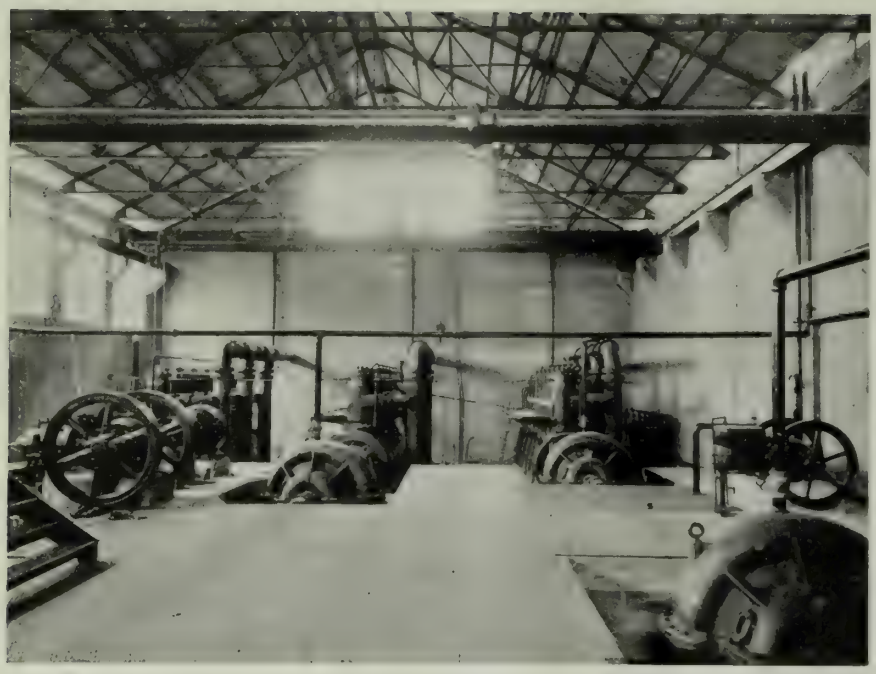

INTERIOR VIEW OF THE NEW PUMPING PLANT OF HIDALGO COUNTY (TEXAS) WATER IMPROVEMENT DISTRICT NO. 4. THREE OF THE SIX PUMPING UNITS ARE SHOWN IN THE BACKGROUND.

The Pumping Plant—Heart of the Modern Irrigation System

How a Texas Irrigation District Worked Itself Out of a Receivership with Oil Engine Centrifugals

By F. T. BANGS

THERE are many areas in this country favored with rich soil and relative nearness to crop markets that lack only abundance of rainfall to make them highly profitable farming districts. Where water and facilities for irrigation at low cost are available, such districts can be developed to become veritable garden spots, as witness the Lower Rio Grande Valley, not many years ago a desert waste and now even with only half its area under cultivation one of the most productive sections in the state of Texas.

Over a century ago the great fertility of the valley was recognized and in the richest part of it, which extends some 75 miles along the river and is about 20 miles wide, primitive attempts at irrigation were made from time to time but led to nothing tangible because no economical and effective means for pumping were at hand. Now this region produces annually some $15,000,000 worth of cotton and about 13,000 carloads of vegetables and fruits.

In the first decade of this century an approach to modern irrigation was made by the installation of a number of small individual pumping plants. These gradually increased in number and showed that irrigation by pumping could be made successful. Consequently larger projects with more efficient equipment were undertaken and irrigation districts organized. These large plants were equipped with Diesel oil engine drive, and on account of their superior operating economy, took over the work of the small privately owned undertakings.

Plants on Lower Rio Grande

They are now operating in the Lower Rio Grande Valley thirteen independent irrigation pumping projects of large scope, besides several small plants. Eleven of these larger projects are organized water improvement districts under state supervision and two are private corporations. They include 450,000 acres, or practically all the cultivated land of this valley, with a farm value of $135,000,000 and an irrigation investment of $20,000,000. Besides the pumping plants and accessory works there are over 1,000 miles of primary distributing canals and main laterals.

One of the most recent and interesting developments that illustrates the modern type of plant that the Rio Grande Valley irrigation districts are now putting in is that of the Hidalgo County Water Improvement District No. 4, whose pumping plant is located near the town of Edinburg, Texas. The district is within a hundred miles of the Gulf Coast and extends several miles north of the river. It has a total area of about 40,000 acres or 62.5 square miles; deducting roads, canal rights of way, building sites, high and low lands, leaves approximately 34,000 acres of irrigable cultivated land. The project area does not extend close up to the river, and hence it has no overflow lands.

Early development of the district, as with many others in the vicinity, was beset with difficulties. A small pumping plant with steam-turbine drive was first installed at the river. This supplied water to about 8,000 acres. During 1910 and 1912 the canal system was improved, and a small relift plant was installed to supply the higher levels. The project was operated by a number of different individuals in succession, but with little profit, and in 1922 it was put in the hands of a receiver.

Startling Facts Disclosed

An investigation of the situation disclosed that the old machinery was nearly worn out, the operating cost of the steam unit being about three times that of a Diesel engine unit. It was found that a more advantageous location of the pumping plant would eliminate the need for a relift auxiliary and that the best way to effect the necessary changes would be to organize a water improvement district.

District No. 4 was therefore formed to take over the project, build an entirely new and strictly modern pumping plant and rehabilitate the canals and lateral distribution system wherever needed. The plant site was relocated ten miles up the river at a point about eight miles west of Mission, a town of 5,000 population. It was also set back from the river over a quarter mile.

THE OUTLET OF THE DOUBLE COMPARTMENT DISCHARGE TUBES WHICH EXTEND 1154 FEET FROM THE SURGE HEADER.

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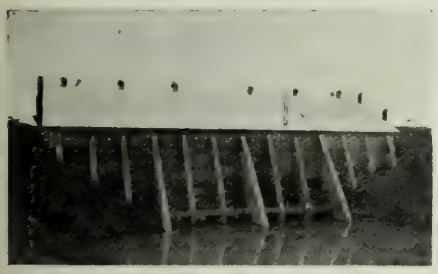
This necessitated excavation of an inlet channel nearly 1,500 feet long from the river to the suction side of the plant. The channel bottom is 30 feet wide and 7 feet below extreme low water. On both sides are levees formed of the excavated material well graded and carried above extreme high water.

The pumping station is a substantially constructed building, 48 by 101 feet, with the floor of the main machinery bays on a level with the bottom of the intake channel; that is, 6 feet below the lowest stage of the river. The walls are monolithic reinforced concrete externally braced by concrete counterforts or plain buttresses spaced 8 feet apart and extending from the foundation to the top of the walls. These can be seen in the view of the suction side of the building. Machinery foundations are reinforced concrete 6 feet thick.

New Pumping Plant Installed

Careful study of the entire power problem resulted in the installation of six oil-engine-driven pumping units, each consisting of a 360-horsepower Fairbanks-Morse Diesel engine direct-connected to a 30-inch Fairbanks-Morse horizontal double-suction centrifugal pump with a rated capacity of 30,000 gallons per minute. As can be seen in the interior view of one end of the pump house, the units are staggered in three parallel rows, the suction and discharge

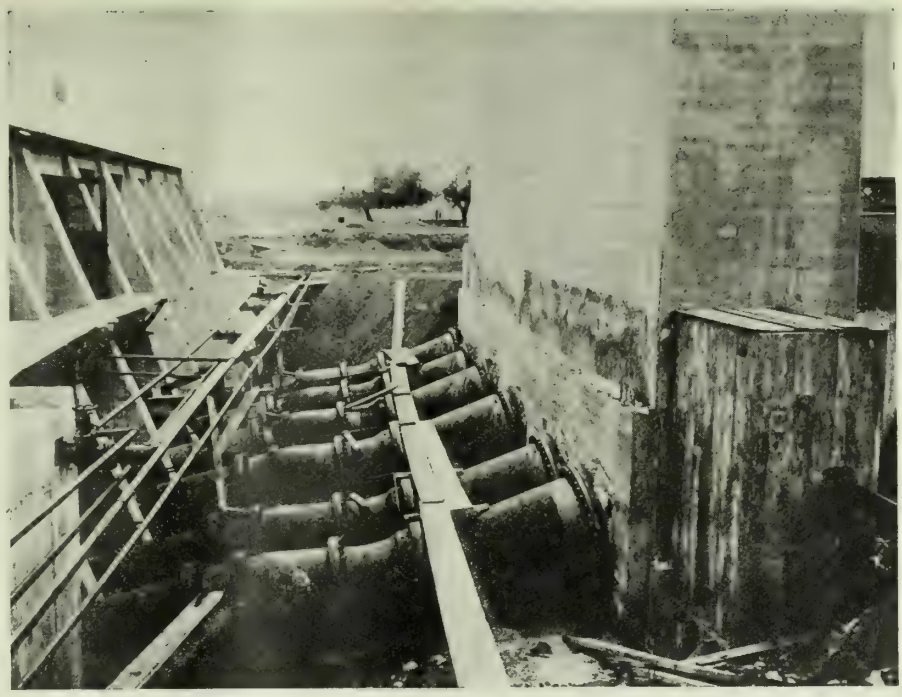


SUCTION SIDE OF THE PUMPING STATION. THE INTAKE CHANNEL EXTENDS 1500 FEET AT RIGHT ANGLES TO THE RIO GRANDE RIVER.

lines passing under and between the pump and engine of the adjoining units, thus making a very compact installation.

At the maximum head of 40 feet each pumping unit handles 25,300 gallons per minute with a pump efficiency of 84.5 per cent. Since the head may be under 20 feet during high water periods in the river, each engine is equipped with a speed regulator to permit slowing down on low heads.

Each pump discharges through a 48-inch pipe to a 48-32 Venturi meter with indicating and recording device to show the discharge rate in second-feet and the total integrated discharge. The Venturi tubes for the meters are shown in one of the accompanying views located between the discharge side of the building and a high concrete surge tank. From this the water passes through two reinforced concrete tubes, each seven feet square and 1,154 feet long, leading through control gates to the main canal and settling basin. These discharge tubes pass under the track of the Missouri Pacific Railway and include two expansion joints.



VENTURI METERS ARE CONNECTED TO THE DISCHARGE PIPES BETWEEN THE PUMPING STATION AND THE SURGE HEADER. THIS AFFORDS ACCURATE MEASUREMENT OF ALL WATER PUMPED.

The main head gates are located at the lower end of the settling basin two miles from the pumping plant. The main canal which carries the water from the plant to the distribution system of the district is about 12 miles long. District No. 4 is laid out in four sections of nearly equal area and the canal is built of full size to reach each section. The system is designed for a twenty-day rotation, five days being allowed for water delivery to each section. All main laterals are built for a capacity of one second-foot for each thirty acres served.

Main Canals of Concrete

All structures in the main canals and main laterals are built of reinforced concrete. The outlet gates from the main canals and laterals are also constructed of reinforced concrete, but the farm outlets from laterals are made of creosoted lumber. A farm outlet is provided by the district to each forty-acre tract, this outlet being located on the commanding ground for that tract. All farm outlets will eventually be equipped with meters and water will be sold on a metered basis, which will doubtless reduce waste and excessive use.

Provision has also been made for the utilization of seepage and excess rainfall by connecting borrow pits to low points and installing oil engines directly connected to horizontal pumps so as to pump the water back into the canal.

With its new development, District No. 4 now has a main first-lift plant in which the head is sufficient to serve the entire acreage to be watered without needing to maintain two or more separate plants. Practically all other district projects in the valley have a main or river plant pumping against a head of about 20 feet to serve the greater part of the lower levels and one or more relift plants to put the water on the higher ground levels at elevations some 10 feet higher.

Hidalgo County Water Improvement District No. 4 now has one of the most modern pumping stations for irrigation service in the world. It is a plant which pumps water with high overall efficiency and with lower first cost than any other plant operating in the Rio Grande Valley. It shows how it is possible to attack the irrigation problem on a sound business and engineering basis. This project can be studied in detail to good advantage wherever irrigation offers an opportunity for profitable land development.

Major C. R. Olberg, who is making headquarters in San Carlos, Arizona, during the construction of the Coolidge dam, spent a few days in Los Angeles early in February.

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The EDITORIAL

MODERN Irrigation

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The Herminghaus Case

SELDOM in the history of the State of California has any decision by the Supreme Court occasioned such general comment and so many protests from the press as the recent decision in the now famous Herminghaus case. The water laws of California at the present time have as their basis the riparian doctrine embodied into the state constitution from the old English common law and fastened more securely upon the state by the decision in the early case of Lux vs. Haggin (69 Cal. 255), and later by the case of Miller & Lux vs. Madera Canal Co. (155 Cal. 59). In the majority of the western states the water rights and obligations are governed by the principle of beneficial use and appropriation, and the courts, as well as the laws, recognize the necessity of conserving water by storage and equalization of streams.

The present decision is generally felt to carry the doctrine of riparian rights to an extreme. It upholds the riparian owner's right to be his own judge of what is "reasonable" in the use of water flowing past his land, and says in effect that so long as any riverbank proprietor can claim that some advantage accrues to him from flooding, the flooding must continue and must not be prevented by upstream storage. It thus prohibits the storage of water for future use and renders impossible the regulation of streams to prevent flood damage.

The opinion was written by Justice Richards and concurred in by four justices. Judge Shenk filed a dissenting opinion. Chief Justice Waste, in a short concurring opinion, states that it is his belief that the judgment correctly disposes of the issues and balances the rights of the parties to the present litigation under the doctrine of the use of water as developed by an unbroken line of judicial decisions in California for seventy-five years. He goes on to say, however, that in his opinion "this doctrine does not best subserve the ends of present requirements and in its application will be entirely inadequate to provide for the future development of the state. The present and future problems arising in connection with the state's most valuable natural resource can best be met by placing a limitation on its use. A rule that limits the right to the use of water to that which is reasonably necessary for beneficial purposes will best meet these conditions. The state has ample power to enact and enforce such a rule, under the police powers reserved to its inhabitants."

The dissenting opinion filed by Justice Shenk is long and vigorously expressed. He holds that California should no longer follow the ruling laid down in the case of Miller & Lux vs. Madera Canal Co., inasmuch as it preceded by four years the adoption of the Water Commission Act, "one of the purposes of which unquestionably was to abrogate the former rule." He points out the fact that "the rule that limits the right to the use of water to that which is reasonably necessary for beneficial purposes is now general throughout the western states and prevails in this state except as between a riparian owner and an appropriator."

Justice Shenk refers to the case of Lux vs. Haggin, and says: "But the conditions prevailing over forty years ago when that case was decided were far different from conditions existing at the present time when the growth and prosperity of the state are so dependent upon the proper conservation of the excess waters of its rivers by storage for irrigation and power uses. That the common law, by its own principle, adapts itself to varying conditions and modifies its rules so as to subserve the ends of present requirements was recognized and decided in 1903 in the case of Katz vs. Walkinshaw, supra. Rights to the use of real property, heretofore deemed vested, have been curtailed in the interest of the public welfare. It is axiomatic that all property is owned and possessed subject to reasonable regulations under the police power. There is nothing peculiar to a riparian right, which is part of the parcel of land itself, that should exclude it from proper limitations in the interest of the people of the state. It is difficult to conceive of a question more intimately connected with the present and future industrial and economic development of the state than the conservation of the ex-

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POINT *Of* VIEW

cess waters of its great rivers. The immediate question involved is: How may the waters in excess of the reasonable requirements of the riparian owners be taken and put to a beneficial use? This question the state has endeavored to solve, at least in its initiatory stage, by the adoption of the Water Commission Act."

"In order to have the beneficial use of less than one per cent of the maximum flow of the San Joaquin river on their riparian lands," he says further, "the plaintiffs are contending for the right to use the balance in such a way that, so far as they are concerned, over ninety-nine per cent of that flow is wasted." And in another place he says: "This waste is not only contrary to the statutory regulation but it works an injustice to the state which is endeavoring to conserve such waters for useful and beneficial uses by appropriators under the laws of the state."

Whatever may be ones opinions as to the merits of this particular decision, it has at least the advantage of having brought before the minds of the people of the state the necessity of clarifying the whole subject of riparian rights and of drafting whatever laws may be required in order that the state may have the right to pool its water and deal it out so that the greatest benefit may be derived. The governor has declared that it is useless for the state to enter upon a great scheme for water conservation without knowing who owns the water and he is conferring with the members of the legislative water committee on the situation. As this issue goes to press a constitutional amendment is being drafted which will define and limit riparian rights, declaring surplus waters to be owned by and subject to the control of the state. The outcome of this will be awaited with great interest by all those concerned with the conservation of water resources.

Corrosion Problems

INTEREST in the corrosion problem seems to continue without abatement and is bringing practical results. At least four important conferences on this subject have been held during the last 5 months. Those interested in steel-frame structures are taking steps to study vulnerable points on account of the failure of some minor parts in certain buildings after 35 years of service. The steam power-plant group, including the railroads, realize the importance of a better knowledge of corrosion, especially under modern high-temperature boiler operations. The chemical and refrigerating industries have already conducted a systematic study of depreciation of metals by corrosion, for which they have spent considerable money and time the last 2 years with encouraging results. More has probably been done to control corrosion in the atmosphere and in closed water systems, because the work on these phases of the problem started over 15 years ago and the important factors are now fairly well understood.

As a result of all this work, there is now little excuse for corrosion in water conduits, recirculating condensers and cooling systems, because economical means of prevention have been worked out to meet nearly all situations where such corrosion occurs. The entire Pittsburgh water supply was treated at a cost of only 33 c. per million gallons and the rate of attack on the pipes was reduced to not over 20 per cent of what it was before the treatment. Yearly damage to water mains in Baltimore is estimated at $300,000 and in New York City at $5,000,000, not including damage to water conduits in buildings. In some cities corrosion is recognized by water works engineers as a major problem.

In view of this situation, an organized and concentrated effort is necessary to get the data needed to apply remedial measures. Perhaps there has been too much detached investigative work in the past. The problem is of such general interest that it would seem to be one that could be attacked to advantage by the concentrated force of the industry as a whole. Whatever is done, however, it is useful to take an inventory of progress periodically.

The Aeroplane and Progress

AN engineer whom we know, and who has figured prominently in the history of the west has told us something of the story of his early work, a story which is familiar to all pioneer engineers. His narration dealt with early public land surveys of the northwestern country, which is now embraced by the states of Oregon, Washington, Idaho, and western Montana. He pictured months of work in a strange country, running survey lines for hundreds of miles through impenetrable forests, each foot of which had to be won from the grasp of nature. He told of the solar compass, that temperamental surveying instrument which was sometimes correct, but which required the patience of a Philadelphia lawyer to operate, and even at its best, was not much better than the ancient instrument of the Egyptians.

Only a little over two score years have passed since that time, yet the younger engineers can hardly picture the hardships of their predecessors. Today, we are still making surveys of new areas, but where it formerly took months, it is now done in a few hours, and the results are quite comparable to the work of pioneers. A recent survey of the Yaqui River Basin, Mexico, was made by aeroplane, we are told, in approximately three and one-half hours. The territory had never before been explored, so it was an entirely new undertaking, yet the information that was required was obtained in a single afternoon. The world is constantly progressing, and each new mechanical achievement finds its application in furthering the progression.

"Western Waterworks" Begins on Page 25

The Standard Form of Purchase Agreement for Deep Well Pumping Equipment

Analysis of Proposed Contract, Sponsored by Western Organizations, Shows It to Be Fair to Buyer and Seller

By ROBERT SCHURMAN

Past President, Pacific Hydraulic Engineering Association

THE standard form of purchase agreement, which has been under discussion for the past two years, is an effort on the part of the pump manufacturers and the representatives of the agricultural interests of California to arrive at some form of contractual relation, which will protect equally, on the one side the interests of the purchaser, and on the other, those of the pump manufacturer and dealer.

For the past five years, there has been a strong feeling on the part of many agricultural organizations that some steps should be taken to insure to the buyer the installation of pumping equipment which will not only meet his present requirements, but will be reasonably certain of caring for his needs during the next few years.

The manufacturers, in the main, have been more than willing to admit the justice of this claim and have been only too glad to co-operate in the formation of any scheme which will serve to stabilize the pump industry, by specifying as clearly as possible to the layman the hydraulic characteristics most desirable for his particular installation, in the hope that with this information clearly brought to his attention, the prospective purchaser will be in a position to decide correctly on the merits of the various proposals submitted for his consideration.

Concerns Deepwell Turbine

In considering a standard form of contract for agricultural service, we have assumed that only the deep well turbine is at issue, and this is probably true of 80 per cent of the installations being made today.

With the growth of irrigation on the Pacific Coast, horizontal pit pumps, generally used at first, were superseded by the deep well turbine to meet the constantly falling water table. Due to increased withdrawals for agricultural purposes and several dry seasons which we have lately had, the turbine has almost superseded all other designs.

It is a matter of passing interest that the deep well turbine, if not actually invented here in California, has, I think I may say without fear of contradiction, been brought to its highest state of development in this State and is now generally recognized as one of our products. It is, in fact, one of California's few manufactured articles in the iron and steel industry, which has a world-wide market, though the major demand is within the State.

The development of the deep well turbine has been closely akin to the automobile. Both started with heavy, slow speed machinery, and due as much to more efficient operation as to present competitive conditions, both have advanced to higher speeds and lighter weights.

With the California market at stake, new manufacturing companies fighting for business have opened plants solely for deep well turbine construction until today there are between 25 and 30 companies, with probably not enough business to allow half this number to operate at a profit.

Competition Forces Lower Prices

The result has been a steady price reduction to the point of vanishing profits and, at the same time, the introduction of sales and service guarantees such as are offered in no other business in the world. In order to operate even on a cost basis some manufacturers have been led to disregard the interest of the purchaser, who, by the way, is buying today on a purely dollar and cents basis, and to give to the purchaser exactly what he has demanded from an hydraulic standpoint, even though it may be a well known fact that the equipment will not be suitable, on account of falling water table, in perhaps as short a time as 90 days. The world old principle of "caveat emptor"—"Let the buyer be on his guard"—has been applied to many purchasers, who have been inclined to consider their needs from price angle only.

To protect both the buyer and seller, the California Committee on the Relation of Electricity to Agriculture two years ago proposed a joint committee for the drawing up of a standard form of contract and this committee, consisting of representatives from the Committee on Relation of Electricity to Agriculture, California Farm Bureau Federation, Western Irrigation Equipment Association and the Pacific Hydraulic Engineering Association, have practically completed the first part of the work and have the contract form ready for approval; but still have to work out for use in conjunction with the contract an approved method of field testing before the new contract form can be put in force.

Features Covered by Contract

From the point of view of the purchaser, their representatives on the joint committee have been very insistent on—

(1) That the hydraulic design of the pump installed be such as to permit of delivering reasonable quantities of water, even though the head may be considerably in excess of that considered at the time the sale was made.

(2) The placing of the pumping element at least 10 feet below the level estimated as correct at time of sale.

(3) The furnishing of some suitable method of determining the water level in the well when pumping.

(4) Adequate protection for the buyer with reference to the delivery date of machinery.

(5) Provision covering test in case of dispute, either before or after installation.

(6) Uniform installation and wiring in accordance with the most approved practice.

(7) Protection to the buyer in case of legal action.

These points have been variously covered as follows:

Paragraph one. With reference to the use of the proper pump by the company making the installation, there has been provided in Paragraph 7, a performance table which shows the quantities of water that the pump will deliver, not only at the head for which it is designed, but also at a head 10 per cent above the normal operating condition, and 10 per cent below the normal operating condition, together with the required horsepower at each of these three points.

This is a very distinct improvement on most of the contracts under which pumps are now sold. At the present time, the usual specification is that the pump will be guaranteed to deliver some definite capacity against a certain definite head. If, then, the well in question does not produce at least this capacity without drawing down below the original estimated depth, the purchaser has no recourse, because he has no method of proving that the pump installed would not meet its guarantee, if there were sufficient water in the well. An additional drawdown of as little as one inch would place the pump outside the guarantee.

"Western Waterworks" Begins on Page 25

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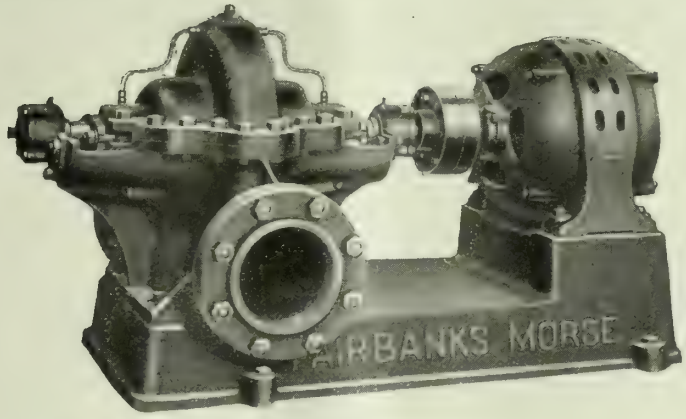

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Furthermore, a deepwell turbine suitable for installation in a 12-inch well, operating at 1750 R.P.M., may easily deliver, for example, 1200 gallons at 100 feet, and yet, at a further drawdown of only 10 feet, be pumping only 300 gallons. It certainly was never anticipated by the buyer, at the time of placing his order, that if he were to make such a small error in estimating his pumping head he would be penalized so heavily.

Pump Performance Guaranteed

Under the new form of contract, the provision which shows exactly what the pump will do at an increased pumping head, protects him fully. By comparing the propositions which he will receive from various manufacturers, he can see at a glance that although two pumps may be offered him, each delivering 1200 G.P.M., at 100 feet, and each requiring the same horsepower, Proposal A," which includes a runner design offering not only this, but, say, 700 gallons at 110 feet, is far better suited to his needs than Proposal "B," which at the normal operating point is giving the same quantity of water, but at a point 10 per cent normal may only be delivering 300 G.P.M.

The pump manufacturers, themselves, who have tried to deal fairly by their customers, are warmly in favor of this change, because with the multiplicity of patterns which they have available, they are in a better position to give, in nearly every case, a more suitable hydraulic performance than can the manufacturer who is compelled to limit his choice to a single pattern which has been developed for normal service, but which is often entirely unsuitable for a different service.

It is generally agreed that the new performance guarantee, which has been included in the form, will offer to every intending purchaser, an analysis of the pump performances which are specified for his particular conditions and thus permit his making a suitable choice.

Paragraph two and three. These have reference to the placing of the pump bowls at least 10 feet below the depth originally estimated as necessary and the furnishing of a suitable means of determining the pumping level when the unit is in operation. These are both taken care of under Paragraph two of the agreement which covers a list of the material that will be furnished by the seller. It is specifically stated there that the bottom bowl is to be 10 feet below the estimated pumping level. It is true that this will involve a slightly additional expense to the purchaser, because it will be necessary for him to buy at the time some 10 feet more of column than is the practice in making sales now, but in nearly every case, with the water table receding as it is, it has been necessary for the owner of a deepwell turbine to add anywhere from a minimum of 10 feet to a maximum of 100 feet over a period of from 1 to 5 years, so it is really to his advantage to spend the extra money for the additional 10 feet of column at the time he makes his original purchase.

This is true because the cost of labor in the installation of the 10 feet of column at time the pump is being installed will not exceed $5.00, whereas if it is necessary for the seller to send a service crew and install another length of 10 feet of column after the plant has been put in operation, the charges therefor would naturally be for the account of the purchaser, and these might run as high as $40.00 or $50.00. In other words, by buying 10 feet of column at the time of making the original purchase, the buyer will save between $40.00 and $50.00, which he would otherwise have to spend within the course of one or two pumping seasons.

The furnishing of a suitable method of determining the pumping level is also a necessity. At the present time most installations are made without such a detector line and consequently it is impossible for the owner of the plant to determine, with any reasonable degree of accuracy, whether or not the pump is really meeting the performance guaranteed by the seller.

The provision covering the installation of the detector line definitely guarantees to the purchaser a method of determining his pumping head and thereby checking up on the performance as guaranteed.

Guarantee of Delivery Date

Paragraph four. There has been a great deal of complaint on the part of purchasers that delivery dates as given in the usual contract form mean nothing. It has been a habit of all sales engineers in the field to specify the very minimum delivery date which any manufacturer will guarantee and to assume that if the pump is somewhat late no real damage will result. This is probably true within reasonable limits, but on the other hand, in the midst of a busy season, it often happens that the minimum delivery guarantee of a factory is hopelessly wrong. Such a delivery date is usually based on the assumption that the order when received will pass immediately through the various departments and shop and permit of the immediate erection of the necessary material.

As a matter of fact, however, the deepwell turbine business is extremely seasonal and it may well be that in the Spring there are some 50 or 100 pumps, all of which could individually be shipped in two or three days, but which by no stretch of the imagination could be given such delivery when considered as a whole.

All contracts become binding only upon execution at the head office of company making the sale. If, therefore, a contract is mailed in and there is a delay of a week or two in executing it, the purchaser would have no option to cancel his order, which specifies delivery in some certain number of days, because that number of days does not start to run until the contract is approved.

Gives Purchaser Legal Rights

In paragraph three of the new contract form, this provision has been altered to guarantee either shipment or installation within a certain number of days after receipt of the agreement at the head office of the seller; in other words, if a 10-day installation is promised, this 10-day period begins to run immediately on receipt of the contract at the factory. This is a distinct improvement because the buyer at the expiration of this 10-day period will have full grounds for cancelling his contract. At present he has no such grounds, because a manufacturer can withhold approval until he knows that he can make the shipment specified in the contract form, which thus causes a delay that would be so serious to the buyer as to set him back an entire year and yet give him no legal remedy.

Under the new form, if delivery is not made as promised by the seller, the buyer can purchase a deepwell turbine elsewhere and feel he is not exposing himself to a law suit. This would not be true at present, i. e. legally, although probably most manufacturers would not insist on a purchaser waiting such a length of time as would jeopardize his interests. In any event, however, the purchaser's remedy has now been made legal.

Performance Tests

Paragraph five. At the present time there is no provision in the usual form of con-

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Following is the Report of Internal Pressure Tests Made by G. T. McIntyre, Inspector for Laguna Beach (California) Water District; J. B. Lippincott Co., Engineers:

Dia.	Nos.	Wall Thickness	Cem.	Mixture Sand	Rock	Age days	Working Pressure in Line	Tested To	Seepage
27″	20	2 5/8″	1.0	2.3	½	14	55 lbs.	110 lbs.	none
27″	26	2 5/8″	1.0	1.0	1.0	14	55 lbs.	110 lbs.	none
27″	3	2 5/8″	1.0	2.3	none	16	55 lbs.	110 lbs.	none
27″	17	2 5/8″	1.0	2.3	none	15	55 lbs.	110 lbs.	none
27″	37	2 5/8″	1.0	1.0	1.0	15	55 lbs.	105 lbs.	none
27″	1	2 5/8″	1.0	2.3	1.4	17	22 lbs.	85 lbs.	none

Note: None of specimens failed at above pressures. All pipe were tested 10 minutes at 10 pounds and 20 minutes at the high pressures without seepage. All pipe were selected at random by the engineer and tests are shown on all pipe so selected.

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"Western Waterworks" Begins on Page 25

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tract with reference to the method to be followed in case the buyer feels the pump is not coming up to its guaranteed performance. In the new contract form, two options have been given to the buyer. He may either elect to have the pump tested at the seller's factory, at the rate of $1.00 per horsepower, with a minimum charge of $20.00, or he may, within 10 days after notification by the seller that the machinery is installed and ready for operation, make written request for a field test.

These two options are extended to the purchaser, because it is self-evident that the cost of making an elaborate test in the field will be very much in excess of a factory test, where all of the equipment is available, and it is felt that, in most cases, the purchaser would be well satisfied with a factory test to determine whether or not the equipment is strictly up to specifications. Such a test, which in the contract is designated as Option "A," Paragraph 10, would be made in accordance with the usual method of the testing laboratory of the pump manufacturer.

If the field test, Option "B," were elected, a test engineer would be named by the buyer from a permanent list of such engineers that has been previously approved by the California Farm Bureau Federation, the Western Irrigation Equipment Assn., and the Pacific Hydraulic Engineering Association.

Role of the Testing Engineer

The general thought behind this selection of a test engineer was that the manufacturers could easily enough approve a list of engineers whom they know to be competent to conduct this test and make this a matter of permanent record. The buyer would then select from this list the name of the engineer whom he wished to conduct his particular test. The engineer would then, within a period of 10 days, investigate the pump performance. If, in his opinion, the pump were up to its guarantee, or if failure to make such guarantee were caused by some reason entirely without the seller's control, then the buyer would pay the cost of such test. If, however, the test engineer found that the pump was not in accordance with its guarantee, the cost of making the test would be borne by the seller, who has the right to bring the pump up to its original performance as guaranteed, or must remove it and refund to the buyer any amounts paid on the contract.

This will cover once and for all the disputed question of who shall test a pump which is presumed not to be operating in accordance with specifications and what method of test shall be followed. As a matter of fact, the method of test has not yet been fully determined and a test code will have to be drawn up and approved by the various members of the joint committee. Until such a code is definitely promulgated, it will be impossible to put the new form in operation, because the very basis of its desirability is a definite method of eliminating dispute on the question of test, and while the contract provides for such a test, it does not determine the exact code under which the test is to be conducted, nor does it name the engineers competent to perform such a test.

Uniform Installation and Wiring

Paragraph six. At the present time there is no uniformity in mechanical installation, nor in fact in electric wiring.

It is provided under the new contract form in paragraph six that where the installation is a part of the contract, as is true in most cases today, the wiring shall conform to the latest rules of the California Railroad Commission and to the regulations of the local power company.

This means that a manufacturer or dealer, operating under the new contract form, will have to furnish to the purchaser a complete electric wiring installation of the latest type and cannot, to save cost, put in dangerous open wiring, such as is now often being done.

Protection to the Buyer

Paragraph seven. This is covered in the new contract form in paragraph 17, which provides that in case of legal action on the part of the seller, the action shall be instituted either in the county in which the buyer's residence is given in the agreement, or the county in which the machinery is installed.

At the present time, practically every contract written provides that in case the seller brings such action, the buyer waives his rights to demand that the action be brought in the county of his residence and allows the seller to bring the action in the county of its home office. It is recognized that this is unfair to the buyer, and the pump manufacturers have, therefore, agreed that in case such legal action is necessary, they will do the fairest possible thing and will bring such action in the buyer's home county, even though it is a well known fact that prejudicial interests may be against them in such a location.

Similarly, if the buyer institutes civil action, he will bring it in the locality of the seller's home office. This proviso was agreed upon by all of the joint committee as the fairest thing, even though it entailed a rather heavy sacrifice on the part of the seller.

The advantages that accrue to the seller under the new form of contract are as follows:

Paragraph four. In this paragraph the buyer agrees to furnish a well adequately cased to a certain depth, of a certain inside diameter, and under this same paragraph the buyer estimates the pumping level in the well for the capacity desired. At the present time there are many cases where a buyer states he has a well of certain diameter, say, 12-inch, and it is found on attempting installation that the lower part of the well is a smaller diameter, possibly only 8-inch. In these cases the pump manufacturer ordinarily has to undergo considerable labor and expense in removing his pump and substituting a smaller pumping element. It is only fair in such a case that the buyer, who owns the well, and who furnishes it, shall stand any extra expense involved, but as matters are at the present time, the buyer usually takes the position that the sales engineer of the pump, the seller, should have made an investigation of the well. This point is now definitely settled and determined under paragraph four and there can hereafter be no argument thereon.

Terms of Sale

Paragraph eight. This definitely determines the terms under which the pumping equipment will be sold. At the present time there is no uniformity, and pump manufacturers are not only operating as such, but as bankers for the entire ranching community. This paragraph provides that there shall be a first payment of not less than —— per cent upon signing contract; a second payment upon completion of the installation and a third payment in ———days after due date of second payment, with interest at—— per cent. The latter two payments have been left open as to percentage and the last payment as to its due date.

The pump manufacturers, of course, are not getting everything they would wish for under this clause, but at the same time, it is

(*Continued on Page 41*)

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WESTERN Waterworks
Supplement to Modern Irrigation
Of Interest Expressly to Waterworks Executives, Contractors, and Municipal Engineers

Design of Banning's Sewage Plant Makes the Utmost of Local Conditions

Installation Recently Completed Shows Possibilities of Adapting Known Methods to Peculiar Topography

By ORMOND A. STONE
Assistant Engineer, Olmsted & Gillelen, Los Angeles

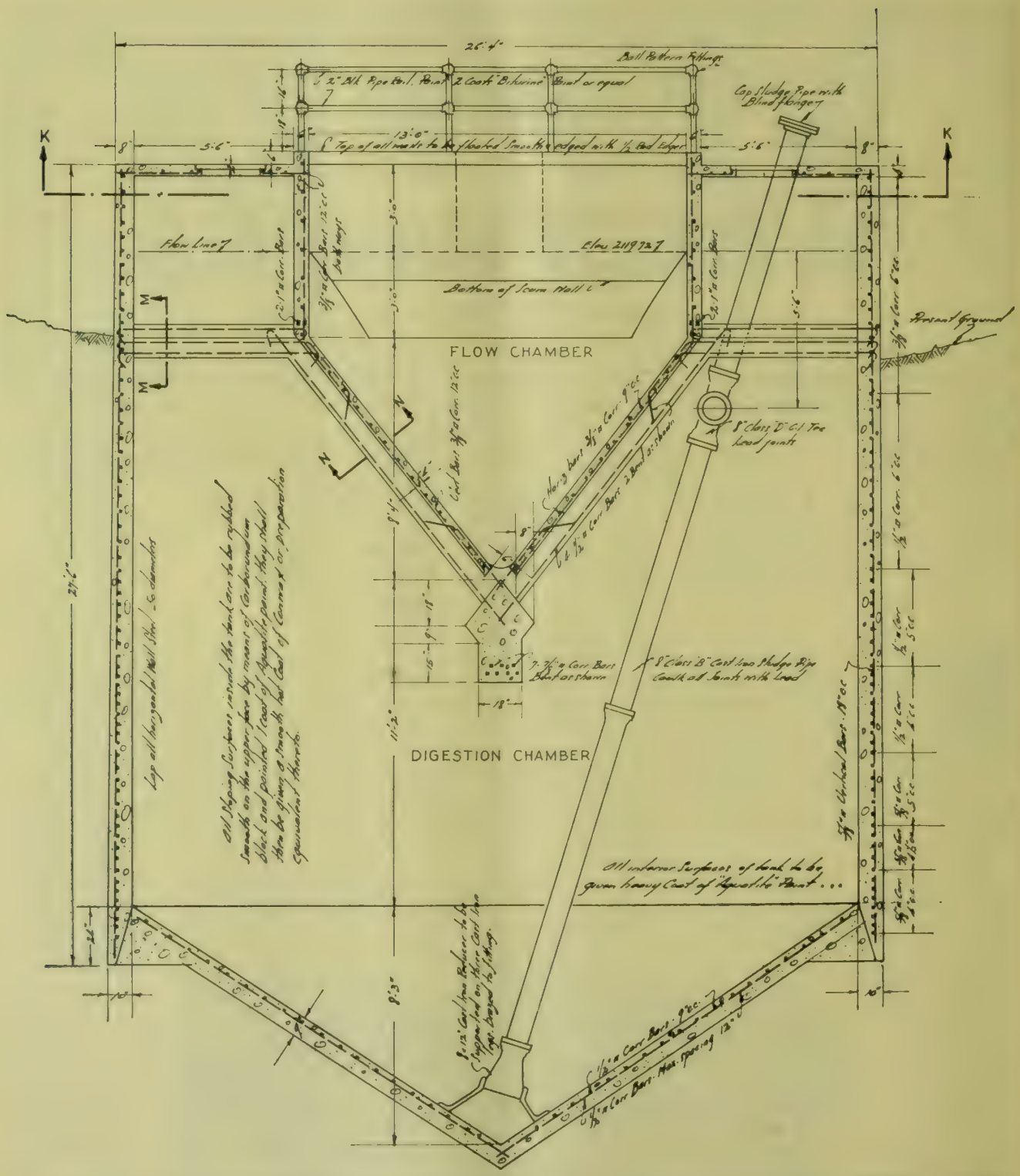
THE sewage treatment plant recently completed for the City of Banning, California, while not being unusual in any of its aspects at the same time presents a rather striking example of the possibility of adapting known and proven methods of sewage disposal to local and topographic conditions.

It is, perhaps, unusual for the designer of a sewage disposal plant to have available a location as ideal in all of its characteristics as that upon which the Banning plant was constructed. Owing to the steepness of the grades no trouble was experienced in bringing the point of discharge at the tank to the approximate ground surface, a problem that is sometimes difficult of solution when working in a country where the ground surface is flat.

The settling tank, which is of the Imhoff type, was constructed on the edge of a wide wash with the elevation of the flow some fifteen feet above the stream bed. At this particular point heavy flood flows in previous years had cut out the bank of the channel leaving a wide sandy bed containing approximately three and one-half acres, not including the stream channel proper, which is now confined by means of pile protection. Having thus available a natural filter bed the choice of the method to be used in disposing of the effluent from the settling tank was obvious.

There remained only to determine the most practical and economical method of applying the treated sewage to the sandy area. In order that the sands might be worked to the best advantage, it was determined to construct a dosing chamber and install automatic dosing syphons to operate alternately in such a manner as to allow a maximum period of rest for each bed upon which the effluent was to be spread. Four ten-inch alternating Miller Dosing Syphons were installed in a reinforced concrete basin twenty-five feet in diameter, each syphon discharging into a fifteen-inch cement pipe line leading to the sand beds, which were

THE INSTALLATION OF THE SEWAGE DISPOSAL PLANT AT BANNING IS ONE THAT IS WELL ADAPTED TO CALIFORNIA CONDITIONS. ABOVE IS SHOWN THE COMPLETED TANK, THE DETAIL DRAWING FOR WHICH IS SHOWN ON THE NEXT PAGE.


FLOW CHAMBER
DIGESTION CHAMBER
Present Ground
Flow Line
Bottom of Scum Wall
All interior surfaces of tank to be given heavy coat of "Aquatite" Paint...

CROSS-SECTION OF THE PRECAST SEWAGE TANK USED N THE BANNING INSTALLATION. THE TANK WAS CAST ON THE SURFACE (SEE TEXT) AND LOWERED INTO PLACE BY EXCAVATING THE INTERIOR MATERIAL.

checked and leveled in a manner very similar to that used in the preparation of an alfalfa field. Each of the dosing syphons is connected by means of ordinary alfalfa valves on the cement pipe line to two checks or sand beds. It is thus possible to so regulate the working of the plant that the rotation of application of effluent to the sands may be made in such a manner as to prevent water logging and to allow cultivation and cleaning.

Interesting Structural Features

The treatment tank itself, as has been previously stated, is of the two-story type and has certain structural features which are particularly of interest where it is necessary to construct the tank entirely below the surface of the ground.

This type of construction was first used by the designers where it was necessary to locate a tank on a salt marsh bordering the ocean. Owing to the expense of the heavy sheeting and crib-

bing, which would be necessary in the case of a rectangular unit, it was determined to make the tank circular in shape, to provide the bottom with a cutting edge and to sink the tank in sections much in the same manner as that used in sinking a caisson. The success, which attended this first installation, was so marked that subsequently the same design has been used in a number of different locations with many different kinds of soil and water conditions, and invariably has been found to be satisfactory and very economical.

Excavation Costs Low

In the case of Banning, while no ground water difficulties were expected or encountered, at the same time the type of design permitted great economy in that absolutely no timbering of the excavation was needed, and the consequent excavation costs were made at a minimum figure.

The tank, as can be readily seen, might be extended in units providing some method were devised by which the direction of flow through the tank could be reversed.

The excellent suggestions made by R. F. Goudey, Division Engineer of the California State Board of Health, were of material assistance to the designers in laying out the plant.

W. C. Seccombe of San Bernardino was the general contractor for the sewer system, and William Ledbetter Company of Los Angeles sub-contractors for the construction of the Imhoff Tank and Dosing Chamber. To both of these firms should be given credit for their pride of workmanship as evinced in the general appearance of the job as a whole.

Engineers Elect Officers

The Society of Engineers of the San Francisco Bay region have elected the following officers for the ensuing year: George E. Tonney, President; John Wallace, Vice-President; William G. Rawles, Treasurer; Albert J. Capron, Secretary. Board of Directors: Geo. T. Waite, R. G. Green, H. H. Ferrebee, Geo. H. Geisler. Past Presidents: Louis F. Leurey and Glen B. Ashcroft.

The Society maintains a secretary's office at 952 Pacific Building, San Francisco, and its regular meetings are held monthly in the Blue Room of the Palace Hotel. The membership is 500 and is composed of all branches of the engineering profession.

Frank J. Rossi, for the past four years deputy city engineer of Modesto, California, has been appointed city engineer and manager of the department of public works, succeeding F. W. McCarton, resigned.

AUTOMATIC PILOT VALVES FOR OPERATION OF THE MAIN CONTROL VALVES SO THAT SEWAGE EFFLUENT IS DISTRIBUTED TO THE FARMS IN ROTATION.

Salt River Valley Project

(*Continued from Page 13*)

increase in the hydro-electric output.

The original power plant at Roosevelt has a capacity of 21,000 H. P. There are four plants located along the canals in the valley with a total capacity of 9,000 H. P. The plant at Mormon Flat has a capacity of 10,000 H. P. making a total of 40,000 H. P. at this time..

The Horse Mesa Dam is now under construction. This dam is between the Mormon Flat Dam and the Roosevelt Dam. This dam is three hundred feet in width above the bed rock. The type is variable radius concrete arch. It is fifty-seven feet thick at the base and eight feet thick on top. This reservoir will be maintained at a steady level and the power plant will operate with a maximum head of 254 feet, and will have a generating capacity of 40,000 H. P. The power which is already being generated and that which will be generated from the new project is now under contract to the mining companies, and local power companies. There are some further extensions to the power systems which are now under consideration, and which will add materially to the revenue..

With the completion of the Horse Mesa dam the farmers of the project expect to realize an annual income under the existing contract of approximately two and one-half million dollars. This revenue will pay off operation and maintenance costs of the project, complete the payment of the debt to the U. S. Government and will pay the principal and interest on all outstanding notes and bonded indebtedness. In addition to this there will be a substantial surplus which will probably be used for the extension of electric lines throughout the project, making it possible for every farmer to have electric power for his home and for the operation of his power machines.

The project investment of the Salt River Valley Water Users Association is in excess of twenty-five million dollars, which is approximately the annual revenue from crops grown on the project.

Buys Harris Air Pump Co.

The Worthington Pump and Machinery Corp. has purchased the Harris Air Pump Co. of Indianapolis, manufacturers of air lift systems and air lift pumps. The purchase was outright and includes patents, drawings, patterns, and goodwill. This new acquisition permits the Worthington Company to offer complete well equipment, including compressor, produced in its own plants.

Asks Sewage Experiment Aid

A bill appropriating $110,000 from the State Treasury for use by the State Board of Health to determine the proper methods of treament and disposal of sewage and industrial wastes has been introduced in the California legislature by Assemblyman Scofield of Huntington Park.

Pipe Company Moves Offices

The Pacific States Cast Iron Pipe Company and the McWane Cast Iron Pipe Company have opened new offices at 608 Subway Terminal Building, 417 South Hill St., Los Angeles. H. M. Dudley is western sales manager for these two companies.

NEWS FROM THE CALIFORNIA RAILROAD COMMISSION

East Bay Water Company has applied to the California Railroad Commission for permission to sell certain non-operative real property in Alameda County, not required for its public utility operation.

P. G. & E. Transfers Water System

Pacific Gas and Electric Company has been authorized by the California Railroad Commission to transfer its Deer Creek ditch water system in Nevada County to Nevada Irrigation District for the sum of $350,000.

Will Sell Common Stock

California Water Service Company has been authorized by the California Railroad Commission to issue and sell at no less than par seven shares of its common capital stock, at $100 per share, and to use the proceeds in part to pay organization expenses in part.

Ask Bond Sale Permit

Montebello Land and Water Company has applied to the California Railroad Commission for the necessary authority to sell $50,000 of its first mortgage 6½ per cent serial gold bonds and the use of the proceeds for the purpose of meeting outstanding obligations and additions and betterments.

Grant Toll Line Right of Way

Spring Valley Water Company has been authorized by the California Railroad Commission to grant right of way to Great Western Power Company of California for a toll line over its property in San Mateo county, approximately 9.7 miles, upon the payment of $40.00 per pole by the power company.

Tuxedo Water Plant Sale

Tuxedo Land Company has applied to the California Railroad Commission for authority to sell, and C. B. Jackson, to purchase, the Tuxedo Water Plant, furnishing water for domestic and other purposes to consumers in Tuxedo Park and adjacent territory in the city of Stockton, for the sum of $22,500.

Haines Canyon Will Sell Bonds

Haines Canyon Water Company has been authorized by the California Railroad Commission to issue and sell $16,000 of six and a half per cent first mortgage bonds, due December 1, 1943, at not less than 97 per cent of face value, plus accrued interest, and to use the proceeds to pay for additions to its properties and improvements.

Whittier Will Issue Notes

Whittier Water Company has been authorized by the California Railroad Commission to issue at not less than face value $86,500 of promissory notes at not exceeding six per cent per annum, and payable on or before two years after date, for the purpose of refunding $70,000 of outstanding trust notes, and to finance additions and betterments.

Fontana Asks Hearing

Fontana Domestic Water Company, operating in the vicinity of Fontana, San Bernardino County, has applied to the California Railroad Commission for an interpretation of its rules and regulations relating to the extending of its service, and a hearing of all complaints now pending involving the company's interpretation of its own rules and regulations.

Commission Sets Purchase Price

The California Railroad Commission has fixed the value of the property of Marysville Water Company, to be paid by the city for the acquisition of the same, as a municipal water plant, at $372,400. The valuation of these properties was made by the Commission on application of the City, and the price named includes $15,000 for materials and supplies on hand.

Ask Land Sale Permit

East Gardena Water Company and the Board of Water and Power Commissioners of the City of Los Angeles have applied to the California Railroad Commission for permission for the former to sell and the latter to purchase a strip of land 65 feet in width through Block 2 of the Beaudry, Downey & Hayward tract in the county of Los Angeles, for the sum of $10,750.

Water System Transfer Granted

L. F. Cowan has been authorized by the Railroad Commission to acquire Agua Caliente Water Works and Boyes Hot Springs Company's water system, and the said Cowan is authorized to transfer the same to Sonoma Water and Irrigation Company for the sum of $9,000, and Sonoma Water and Irrigation Company is authorized to acquire and operate the same as a portion of its existing water utilities.

Grant Water Merger

Permission has been granted by the California Railroad Commission to Rogers & Sons to transfer to Nelson M. Van Fleet a public utility water system supplying consumers in the townsite of West Cucamonga, San Bernardino County, and the latter has been authorized to merge that system with the system of California Vineyard and Improvement Company, Nelson M. Van Fleet sole owner, and to apply the existing rates, rules and regulations of the Vineyard Company to the merged systems.

Moorpark Boosts Water Rates

Finding that Moorpark Farmers Water Company is operating under inadequate rates the California Railroad Commission has authorized that utility to establish a new schedule of rates calculated to produce a slightly larger return on the investment. The rates include the following charges: Minimum annual charge $12.00 for first year per acre; $9.00 per acre for each consecutive year thereafter; irrigation service, January to September, inclusive, 2 cents per miner's inch; from October 1 to December 31, 1½ cents per miner's inch.

El Pizmo Stock Issue Authorized

Citizens Water Association has been authorized by the Railroad Commission to sell to El Pizmo Water Company the public utility water system recently taken over by the Association from W. W. Ward, under the authority of the California Railroad Commission. The Commission has also authorized the El Pizmo Water Company to issue $10,000 of six per cent cumulatice preferred stock and $10,000 of common stock in payment for the property. The company is also authorized to issue and sell at not less than par $16,000 of six per cent cumulative preferred stock, and $8,950 of common stock, and to use the proceeds for improvements under authorization of the Commission. The company is also authorized to issue five shares of common stock to its incorporators.

Asks Water Contract Approval

San Dieguito Water Company has applied to the California Railroad Commission for the approval of a contract and lease of certain water properties to the City of San Diego. Applicant recites that it does not admit that it is, or ever has been a public utility, as found by the Railroad Commission in a recent decision, but that it is applying for approval of the said lease for the purpose of removing any question that might arise in the future in regard to the validity of said contract, and that it abandoned entirely the sale and delivery of water on December 1, 1925, and has never resumed such sale and delivery of water since that time.

Boosts Rates With Conditions

Plymouth Water Company, operating in the town of Plymouth, Amador County, having applied to the California Railroad Commission for an increase of its meter rates, alleging that they were not producing a sufficient revenue to pay cost of operation and bring in a fair return upon the investment, has been directed by the Railroad Commission to make needed improvements in its service, upon which small increase in rates is conditioned. The Commission found that the system was planned for a larger population than now exists in this territory, and the Commission cannot allow a full return upon the entire property. The new rates are expected to produce a return of approximately 3 per cent per year over the cost of operation.

San Diego and Cuyamaca Make Deal

City of San Diego and Cuyamaca Water Company have applied to the California Railroad Commission for approval of a contract under which the city will purchase from the water company the distributing system, mains, and laterals, serving the East San Diego, Normal Heights and Kensington Park districts of the city of San Diego, together with a guaranteed supply of water amounting to not less than 1,000,000 gallons per day, the same being excepted from Cuyamaca Water Company's properties recently sold to La Mesa, Lemon Grove and Spring Valley Irrigation District for the sum of $1,100,000. The price to be paid for the water to be supplied in the three districts named is fixed at nine cents per 100 cubic feet until changed by competent authority.

Water Combine Plans New Financing

California Water Service Company has applied to the California Railroad Commission for authority to issue to Federal Water Investing Company, Inc., $1,499,300.00 of its common capital stock in exchange for the option contract to purchase Chico Water Supply Company, Port Costa Water Company, Fresno City Water Corporation, Visalia City Water Company, Electric Water Company of Bakersfield, Bakersfield Water Works and Hermosa-Redondo Water Company; and to issue and sell $6,600,000.00 first mortgage gold bonds, Series "A," to net 90 per cent of par value; $2,500,000.00 preferred stock, to net 87 per cent of par; $1,000,000.00 of common stock; and to borrow from Federal Water Service Corporation upon a promissory note $27,980.05, and to use the proceeds derived from the sale thereof to finance acquirement of such properties, and to liquidate their outstanding indebtedness, including $2,355,000.00 due to Pacific Gas and Electric Company for the pur-

chase of its water properties in Stockton, Oroville, Redding, Willows, Livermore, Dixon and vicinities.

San Dieguito Asks Rehearing

San Dieguito Water Company, the City of San Diego, Santa Fe Irrigation District and Del Mar Water, Light and Power Company, have filed a petition with the California Railroad Commission for a rehearing of the complaint of Milton A. Smith Realty Company against San Dieguito Water Company. In an order issued, after a hearing of this complaint, the Commission found that San Dieguito Water Company is a public utility water company, but had not dedicated its plant to the service of the lands of complainant company, and in a separate order the Commission instituted an investigation into the affairs and operation of the San Dieguito Water Company, with the view to determining why it should not serve the lands of complainant and others. The companies joining in the petition for a rehearing allege that they would be affected adversely if the Commission holds the defendant company to be a public utility water company, and would be forced to abrogate existing contracts between the water company and the other petitioners who join in the proceedings as interveners.

Fixes New Rates for Petaluma

Finding that the rates of Petaluma Power and Water Company for water served to its consumers in the city of Petaluma and adjoining territory in Sonoma County, are not resulting in an equitable distribution of the charges to the various consumers according to the character of their respective uses of water, the California Railroad Commission today established a new schedule of rates for that company designed to distribute the cost of the service more equitably and designed to produce the necessary increase of revenue. Following are the new rates:

Minimum monthly charges: for ⅝-inch meter, $1.25; for ¾-inch meter, $1.75; for 1-inch meter $2.50; for 1½-inch meter, $4.50; for 2-inch meter $6.00; for 3-inch meter $10.00; for 4-inch meter $16.00.

Monthly quantity rates: From 0 to 800 cubic feet, per 100 cubic feet $0.35; from 800 to 3,000 cubic feet, per 100 cubic feet $0.24; from 3,000 to 15,000 cubic feet per 100 cubic feet $0.18; all over 15,000 cubic feet per 100 cubic feet $0.12.

Municipal and county use: 1. Water used for street sprinkling and sewer flushing, by computed or measured quantity, per 100 cubic feet, $0.18; 2. For each fire hydrant installed by the city, $2.50; 3. All other municipal use of water, including public buildings, schools and irrigation of parks and grounds, to be charged for at the regular meter or flat rates.

Flat rates, where service connections are installed solely for use of automatic fire sprinkler systems or for private fire protection purposes: For 6-inch service connection, per month $9.00; for 4-inch service connection, per month $5.00; for 2-inch service connection, per month $2.50.

E. C. Eaton has been appointed chief assistant engineer of the Los Angeles Flood Control District and will begin his duties on March 1. Mr. Eaton has been for the past five years irrigation engineer for the state department of public works, California, and was previously connected with the Lindsay-Strathmore, Terra Bella, and Merced Irrigation districts in California.

Water System Plans Approved

Plans for water main installations, an essential preliminary to the paving of Long Beach Boulevard, Los Angeles County, have been submitted by Major Walter H. Adams, county hydraulic engineer, and approved by the Long Beach, California, city water department, according to a recent statement by Captain Burt Harmon, municipal hydraulic engineer. The section of the boulevard to be improved is approximately five miles in length. The water transmission line will be a 12-inch main, 27,960 feet long. Besides the 12-inch main, 4680 feet of 6-inch pipe will be laid for laterals and fire hydrant connections. It is only boulevard frontage that is to be served by the water system provided for in these plans. Water pipe and fittings for the job will cost $78,000, to which must be added the cost of labor.

Siphon Given Pressure Test

The Moreno Mutual Irrigation Company, near Riverside, California, and engineers from Los Angeles made a recent test of the six-mile steel inverted siphon just completed by the company and report that the results were highly satisfactory. The unit tested has cost the company $145,000. It consists of six miles of twenty-four-inch, double-riveted, double-dipped and wrapped steel pipe. It is one great inverted siphon, with the intake sixty-eight feet higher than the discharge. Into the steel siphon will be delivered the water from the five new wells on what was once known as the Singleton ranch, a property of 700 acres and valuable chiefly for its water.

City Water Outlook Bright

Well No. 1, at the Charnock Road plant of Santa Monica, California, is now producing 200 inches of water, or 2,288,000 gallons per day, according to a recent report by Commissioner John A. Morton, head of the public works department. This is more than half of all the daily water consumption of Santa Monica from this one well alone. The increase in yield, Mr. Morton explains, is due to the fact that the motor horsepower at the pump has been increased from 70 to 100, and the pump bowls lowered to a depth of 200 feet. The well is 389 feet deep, and the water stands at a level of 106, just where it stood when the well was first put into service.

Water has been struck in Well No. 5 at this plant, Commissioner Morton reports, and the gravel indications are even better than they were in No. 1. Requisitions for a motor and pump for this new well have been voted by the city council.

Col. H. B. Maxson Dies

Col. Herbert B. Maxson, mining and civil engineer and member of the California State Republican Committee, died at his home in Los Angeles on January 27, following an attack of acute indigestion. Colonel Maxson was one of the pioneers in the National Irrigation Congress, which he served for eight consecutive years as its secretary. He also served on the Panama Canal staff.

Buys New Water System

The purchase of the Tuxedo Park Water Company by the California Water Service Corporation has been announced by C. B. Jackson, vice president and general manager of the corporation. The system, which serves the residents of a suburb of Stockton, California, was purchased from the Tuxedo Land Company of that city.

Snows Boost Water Supply

Snowfall in Colorado has been very heavy this year, according to recent accounts from Grand Junction, and more than normal depths are reported from various watersheds. Six feet of snow on Grand Mesa, one of the most important watersheds, practically assures full reservoirs in the spring.

Olympia Looks to the Future

Investigation of sources of future watre supply for Olympia, Washington, has been started by J. L. Stannard, consulting engineer of Tacoma. The Satsop and Skookumchuck rivers will be among the sources looked into, it is said. A report of the investigations is expected to be ready in February.

Two New Wells for City Water

Contracts have been let by the city of McCook, Colorado, for the construction of two new wells to furnish a guaranteed supply of 600 gallons of water a minute, and of a reservoir of 500,000-gallon capacity, as an addition to the waterworks system, at a cost of approximately $44,000.

D. C. Warfel, formerly county engineer of Okanogan County, Washington, has resigned his position with the intention of loacting in California and taking up the practice of engineering there.

Walter J. Nichols, assistant city engineer of Fullerton, California, has been appointed city engineer, succeeding W. C. Record, resigned. H. A. Hiltscher succeeds Mr. Nichols as assistant engineer.

METERS & METERING

Orifice Meter Boosted for Its Low Cost, Easy Installation and Accuracy

By G. D. CONLEE*

EVERY one interested in waterworks engineering is familiar with the use of the venturi tube for the measurement of water flowing in pipes. The venturi tube has been a commercial article for nearly 40 years, and during that time it has become the standard method for the measurement of cold water. The constants have been established and the limitations are known, so that a venturi tube can now be installed with the expectation of satisfactory results.

Developments in other fields of engineering have led to the adoption of the thin plate orifice for the measurement of fluids, which includes steam and gases. You doubtless know of the use of orifice flow meters for the measurement of steam. I want to take this opportunity of bringing to your attention the advantages in the use of this type of meter for the measurement of water.

The venturi tube, the flow nozzle, and the orifice, as well as the other differential mediums used with the various flow meters now on the market, have common characteristics in that the flow through the primary element produces a pressure difference which the secondary element translates into rate of flow. This difference is between the static pressure at two different sections of the stream.

If a small hole is drilled perpendicularly through the wall of smooth pipes along which fluid is moving, the inside edge of the hole free from burr, and the hole is connected to a pressure gauge, the observed pressure is called the "Static Pressure" of the fluid that is moving past the hole.

Equations of Head Meter

The theoretical equation of the head meter, that is the venturi tube, flow nozzle or thin plate orifice is:

$$Vt = A_1 \frac{1}{\sqrt{R^4 - 1}} \sqrt{2gh}$$

Where Vt=theoretical rate of discharge, cu. ft. per sec.

A_1=area of the entrance section at the upstream pressure connection, sq. ft.

R=ratio of entrance to throat diameter D_1/D_2.

g=acceleration of gravity 32.174.

h=difference of level (ft.) at which the liquid stands in two vertical tubes which are connected to the side holes at entrance and throat respectively, and are either open at the top or connected through a closed air space.

The factor $\frac{1}{\sqrt{R^4 - 1}}$ depends only on the diameter ratio and is independent of the absolute size of venturi, nozzle or orifice.

The factor A_1 is fixed only by its absolute size. These two factors may be combined into a single constant,

$$M = \frac{A_1}{\sqrt{R^4 - 1}}$$

which can be computed once for all for any installation and the equation becomes

$$V_1 = M \sqrt{2gh}$$

For various reasons, which will not be discussed here, the rate of flow V (cu. ft. per sec.) observed is usually different from the theoretical value, and the practical equation is

$$V = C\,M \sqrt{2gh}$$

in which C is the discharge coefficient.

Principle of Venturi Tube

In 1887 Clemens Herschel conducted a series of hydraulic experiments on various sizes of tubes composed of two conical portions joined at the small ends, thus forming a contraction near the middle. As a result of these experiments, the design of tubes now in common use was established and as the final outcome of the experiments a patent was granted to Mr. Herschel on the device which he named a venturi tube. Beginning at the upstream end, it consists of a short cylindrical portion, machined to a definite diameter and containing the side holes for measuring the upstream pressure. Then comes the entrance cone which reduces the diameter to that of the throat which is accurately machined and has side holes for taking off the throat pressure. The end of the throat leads into the exit cone or diffuser, which increases the diameter to that of the pipe line.

If the venturi tube is well made and properly installed, the value of C is between 0.97 and 1.00 with the mean value of 0.985 generally used.

Thin Plate Orifice

The thin plate or sharp edged orifice was used for many years to measure rates of discharge from tanks into the open air. It was also known that an orifice in a straight run of pipe could be used for the measurement of water, provided the orifice was calibrated in place; that is, it was an accepted fact that an orifice would produce the same differential pressure for the same rate of flow at all times. It was not until about fifteen years ago that any one conceived the idea that an orifice could be designed to meet definite conditions and could be used for measurement of water in exactly the same manner as a venturi tube. A number of independent investigations were started and a very respectable volume of data has been collected. Since that time various tests of orifices have been made under all sorts of conditions, and the accuracy of the data and the consistency of performance has been established. When the same care is taken with the installation of an orifice as with a venturi tube, the same accuracy of results can be guaranteed.

In its simplest and most familiar form, the orifice is merely a round hole in a thin flat diaphragm clamped between the flanges at a joint in the pipe line, with the hole concentric with the pipe. In practice the orifice is usually made from sheet monel metal from 1-32 in. to 1-16 in. in thickness. At times a thicker plate is used and the plate is then chamfered around the hole on the downstream side so as to leave only a thin edge, while the upstream face of the plate remains flat, with a sharp 90 degree corner at the edge of the hole.

It is a familiar observation that a free jet of water from a sharp-edged orifice is not cylindrical but contracts at first. On account of the flow inward toward the orifice on the upstream face of the diaphragm, the outer filaments of the jet as it leaves the orifice, have a component of velocity toward the axis, so that the profile of the jet is concave and decreases in width. At a certain distance from the plane of the orifice, the jet has a minimum section, or vena contracta, where the area is constant for a short distance. The highest speed and lowest static pressure are not reached in the plane of the orifice but at the vena contracta, which

*A paper read before the Manufacturers' Association meeting at the annual convention of the American Water Works Association.

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corresponds to the end of a flow nozzle discharging a jet of water into the open air. The jet from a thin plate orifice inserted in a pipe line acts in a similar manner.

If the orifice is small compared with the pipe diameter, the result is merely a jet from one large space to another. As the orifice diameter is increased to a larger and larger fraction of the pipe diameter, the vena contracta moves closer to the plane of the orifice and the jet is surrounded by a dead space filled with eddying water. The jet is thus retarded and it must expand in cross section so that after a few pipe diameters it fills the whole section of the pipe. It has not been proved definitely that the pressure in a side hole must be the same as it is in the jet at the same distance from the plane of the orifice. However, it has been shown by visual tests in glass tubes that the vena contracta is in the same plane as the side hole showing the lowest pressure. Therefore, this pressure may be considered the same as the static pressure in the vena contracta.

If the diameter of the vena contracta could be measured directly, the discharge coefficient in the equation given previously would be nearly unity because the speed actually attained in the vena contracta is closer to the theoretical value than is the throat speed of the venturi tube. Since the diameter of the vena contracta cannot be measured directly, the diameter of the orifice is used and this accounts for the coefficient being from 0.60 to 0.62, depending upon the sizez of the pipe and the orifice ratio.

Orifice Installation

It is usually possible to select a flange in the line where an orifice can be installed without any change in piping. Twelve diameters of straight pipe on the high pressure side of the orifice is ample to insure satisfactory results under any conditions of flow. In practice this length of straight pipe is not always available. The length actually necessary for satisfactory results depends upon the ratio of the orifice diameter to the pipe diameter and also the velocity of the flowing fluid.

The orifice is inserted in the pipe between gaskets. It is made of a proper size to fit inside of the bolt circle and has pins on the handles to center the opening in the pipe. The two pressure taps are made one on each side of the orifice. A ⅜-in. pipe connection is all that is required and it can be tapped directly into the wall of the pipe. Care must be used that the nipple does not project into the pipe on the upstream side of the orifice because an asperating effect may be produced that will affect the accuracy of the meter results.

In case of bell and spigot pipe, the orifice is put in at the bottom of the bell and held in place by the spigot. When the joint is made the orifice is solidly held and it is only necessary to make the pressure connections on either side of the orifice.

The orifice is comparatively inexpensive, consequently it can be designed for present needs. Should increased demand occur, it is a simple matter to install a new orifice of increased capacity. This is one very important advantage of the orifice. When distributing systems are laid out there is always a liberal allowance made for future growth. Consequently if the meter is designed for the ultimate capacity, it will be operated for a number of years below half capacity, and the accuracy may be in question during low flow periods. Initial readings are very important because they serve as a starting point for checking future growth and it is well worth the small additional expenes to have meters which at all times will read within the most accurate range.

The ease of installation and small interruption of service makes it possible to install district meters in lines already in service. When bell and spigot pipe is used, it is possible to install an orifice using ordinary fittings without the delay caused by waiting for special flanged pipe.

It is customary to guarantee an accuracy within 2 per cent for flow meters when properly installed. This guarantee is based upon the installation of the orifice in commercial pipe. If the pipe section on the high pressure side of the orifice is machined to exact size for two pipe diameters, a guarantee of accuracy within 1½ per cent can be made.

The orifice is made from monel metal and the pressure drop through the orifice is so low that there is no cutting of the edge to enlarge the orifice size. Neither is there any deposit of sediment on the edges of the orifice that will reduce the size of the opening. In practice the orifice remains clean and the accuracy is maintained. There are orifices that have been in service for ten years, and the accuracy is the same as that when first installed.

B. E. Stoutemyer, of Portland, Oregon, district counsel for the United States reclamation district, is visiting the various reclamation projects in western Oregon and Idaho to discuss government contracts to be made with irrigation districts. During his trip he expects to confer with the directors of the Black Canyon district, of the Vale and Warm Springs districts, the Owyhee, and the American Falls districts.

California's Water Plan

(*Continued from Page 15*)

local needs throughout the length of the two valleys. In this way the new supply may be obtained with full protection to established properties.

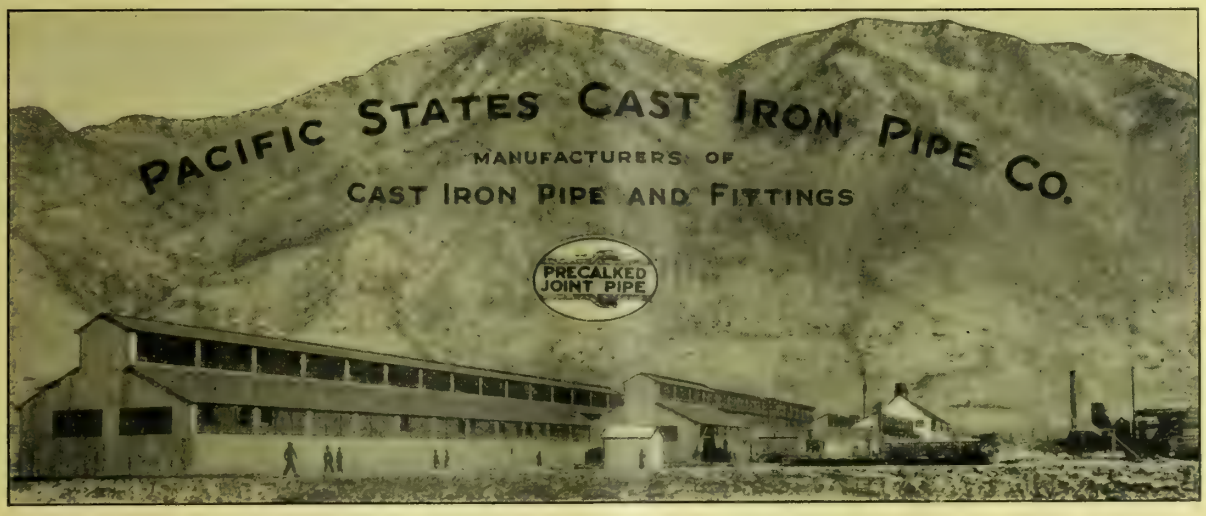
Accordingly, the new supply for the San Joaquin Valley would be derived from the water used to maintain navigation in the channel of the Sacramento River. After serving its useful purpose in the Sacramento Valley, this water would be diverted at the mouth of the river into the San Joaquin. Passing through the channels of the island region forming the delta of the Sacramento and San Joaquin Rivers, it would be boosted up the main channel of the San Joaquin by a series of pumping plants, each one pumping the water over a low dam to the higher level of the pond behind it. These dams would be collapsible so that they would not obstruct the channel during the flood season. They would be so located that, if desired, locks could be constructed along side them that would make the San Joaquin River navigable for a distance of 160 miles from its mouth.

Would Conserve Water

This series of dams and pumping plants, extending the length of the main channel on the valley floor, would also constitute a means of conserving the scant water supply of the San Joaquin Valley. Water entering any section of the channel would be caught by these dams and redistributed throughout its length by the pumping plants. Thus water entering the lower reaches of the channel that often escapes into Suisun Bay, could be readily utilized by the greater area upon which it could be served.

The new supply of water obtained through the operation of these dams and pumping plants would be distributed to the lower lying lands in the San Joaquin Valley in order that the pumping lift may be a minimum. This would release San Joaquin water now used on these lower lands, at high elevations for diversion by gravity to the lands in the southern San Joaquin Valley that need more water. In this manner, the new supply could be obtained with a maximum pumping lift of 160 feet. The exchange of waters would save 340 feet of pumping lift. All plans for conducting the new supply directly to the higher lands that need water, either by gravity or by pumping, were found to be prohibitive in cost. The only plan of practicable proportions includes exchanges of water and involves properties extending the entire length of Sacramento and San Joaquin Valleys. The

(*Continued on Page 36*)



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STORAGE & DISTRIBUTION

Proper Utilization of Stream Run-Off Records Important Development

By FRED F. HENSHAW

*District Hydrographic Engineer, U. S. Geological Survey, Portland, Oregon**

THE problems of water utilization which are now coming up, involve in all cases the development of storage, the conservation of otherwise unused water, and its application to irrigable lands. Storage may be considered as falling into two classes; seasonal storage designed to hold water from the winter until the summer season, which is utilized practically each year, and holdover storage, designed to carry water that would otherwise be wasted in a wet year over to a season of low run-off. Hardly any reservoir provides one kind of storage to the entire exclusion of the other. In general, when the storage cost per acre-foot is high it is not economical to provide for holdover; when the cost is low it is economical and desirable to do so. It is my purpose to discuss briefly the relation of the variation in yearly run-off on certain streams, the economic utilization of this water, and the extent to which holdover storage can be economically provided. The consideration of these problems is vital to a proper study of the economic utilization of any stream.

Yearly Variation

The variation of run-off from year to year is much greater in some stream basins than in others. In general, the greater the precipitation and rate of run-off, the smaller is the variation. The greater the ground storage and the larger percentage of flow from springs, the more steady is the run-off year by year. For large river basins like the Columbia and the Colorado there is a diversity factor due to the inclusion within one river system of areas which may not be subject to the same laws of variation, but in general for streams of the size of the Willamette, Deschutes, Yakima, and most of the rivers in the Northwest used exclusively for irrigation there is practically no diversity factor apparent.

A method which offers some very interesting conclusions is the study of the fluctuation of certain inland lakes without outlets. A study of this kind was made in connection with the cooperative report on the Warner Lake Project in 1915. A diagram is presented showing the variation of Warner Lakes from the early 1860's down to the time of the report. Mr. E. C. La Rue of the United States Geological Survey in a manuscript report made in 1922 shows a similar diagram for Tule Lake in Klamath County. This lake has no outlet except into the lava at high stage and until about 15 years ago was fed by Lost River, a stream on which little irrigation development had taken place. Settlers have lived on or near Tule Lake for practically 50 years, and as early as 1846 the immigrant trails followed along the shore of the lake.

Tule Lake District

The evidence furnished by these two graphs is fairly consistent. That for Tule Lake shows a period of very low water from 1846 to 1852, followed by a fairly rapid rise, culminating in 1862. The Warner Lake study, based for these earlier years on less satisfactory information, shows a peak about 1868, following a rise from a moderately low stage in 1860. During the 70's both lakes were falling almost continuously. There was a recovery in the early 80's followed by a drought from 1886 to 1889, which was somewhat less marked in the case of Tule Lake than for areas farther east. The year 1890 was one of heavy rainfall. We know that Silver Lake in Lake County was dry for two or three years previous, but completely filled in 1890. From then on for nearly 20 years there is no evidence either of extreme drought; all the lakes were fairly full without any unusual high water. Beginning with about 1910 Tule Lake fell rapidly due to the withdrawal of its water and its stages do not constitute a measure of climate. We have the records of the tributary inflow, however, which has been relatively small since about 1915.

The Warner Lakes began to shrink about 1910 and by 1918 they had reached a very low level. In 1924 and 1926 even Hart Lake, the deepest of the depressions, was practically dry. Although in no other basin has it been possible to draw a graph comparable to those presented, there is abundant evidence confirming their general characteristics. Goose Lake overflowed in 1868 and again for a few hours in 1882. Its stage is now about 20 feet below the point of outflow. I understand that within the last few months water has fallen sufficiently to expose an old immigrant road near the lower end, which was used about 1850, and has been under water continuously since that time. There is abundant evidence of a drought of considerable extent in the late 80's but it was not as long continued as that of the last decade. Malheur Lake in Harney County, a fairly shallow lake, was completely dry in 1889, but Harney Lake, a deeper body of water, was not dry at any time although it has been dry almost continuously for the last 6 or 8 years.

Study of Records Necessary

I cannot attempt fully to interpret this information or to show its bearing on irrigation development. It would appear that periods of drought may be expected once in 30 or 40 years. These periods of deficiency will be separated by periods of adequate precipitation and run-off. There is no evidence that the dry cycle of the last decade is any more severe than has been experienced previously. There is no reason to believe that we may not be on the verge of a wet cycle. It would be extremely unwise to start any irrigation development a few years hence on the basis of a recurrence of heavy stream run-off. It would be just as unwise to assume that the present drought is going to continue indefinitely. Development must take into account both the wet and dry periods. To what extend should we be pessimistic or optimistic in our plans for water utilization depends on many factors—relative cost, storage possibilities, and crop values? We must approach the question to a degree on the basis of insurance. To what extent are occasional losses permissible and how far should expenditures be made that are largely in the nature of insurance against loss? To what extent is it necessary from the psychological standpoint to provide against any water shortage whatever? I do not attempt to answer these questions but every engineer or irrigation executive must be prepared to do so, in connection with his own particular problem.

*A paper read before the Oregon Reclamation Congress, at Portland, Oregon.

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Paul Bailey's California Water Plan

(*Continued from Page 32*)

exchange of water is now practiced in several western states.

In diverting the water used for navigation in the Sacramento River to the San Joaquin, a certain portion would escape into Suisun Bay unless a physical barrier were constructed below the junction of the two rivers. Investigations of the cost of such a barrier have been completed recently in cooperation with the United States Bureau of Reclamation. These reveal that the probable cost would vary from $45,000,000 to $90,000,000 according to the site selected. This exceeds considerably the cost of developing the volume of water that would escape into Suisun Bay if no barrier were constructed. At some future time when this volume of escaped water is needed for irrigation in the San Joaquin Valley, a physical barrier could be constructed in order to make it available. In the meantime, the escape of this water into Suisun Bay would automatically dispel the menace of incursion of salt water into the channels of the delta region. The volume of water desirable for navigation in the Sacramento River is adequate for both salt water control and diversion into the San Joaquin Valley for a long time. Thus, the coordinated plan avoids the large cost of a barrier for many years to come.

Levees Necessary

In pumping the new supply from the Sacramento up the grade of the San Joaquin River, it will be necessary to construct levees along the banks of the river for a distance upstream from each dam in order to confine the water to the stream channel at its increased level. The required height of these levees would grow less as the next upstream dam is approached, until at some intermediate point, the ponded stream would be confined within the natural banks of the channel. The coordinated plan proposes to incorporate these levees in a general plan of reclamation for the overflow lands of the San Joaquin Valley.

Unlike the Sacramento Valley, the strip of overflow land in the San Joaquin is so narrow that the reservation of a channel large enough to pass the maximum flood, leaves an insufficient area benefited to pay for the cost of the levee system. Although much study has been placed on plans for reclaiming these overflow lands, an economic plan of complete reclamation has not yet been devised. However, opportunity is afforded by the coordinated plan to improve these conditions because the required width of flood channels could be reduced if the scheme of reservoir operation devised by these investigations, were applied to the reservoirs on the tributaries of the San Joaquin that are either already constructed or will be required to meet the demand of the next few years for irrigation water. These will have sufficient capacity to reduce flood volumes without interference with conservation, to nearly half their maximum flow except for the lower one-third of the main river channel. On this section some reduction could be effected but not as much as on the upper two-thirds of the channel.

At some later time, a greater degree of flood control can be effected on the San Joaquin River than here described. The reservoirs now constructed and at present contemplated on its tributaries will not develop the entire run-off of these streams. Additional storage will have to be provided at some future time for conservation purposes. By including this additional storage in the flood control system, floods may be reduced to smaller volumes than described above. This additional storage is part of the comprehensive plan for the ultimate development of the San Joaquin Valley, but is not included in the units here suggested because it will be some time before it is needed for conservation purposes.

Power Here, Too

Large reservoir units, sufficient in size to make the entire run-off of the streams available in the controlled supplies, are included in the coordinated plan for the southern part of the San Joaquin Valley. Such a large fraction of the entire stream flow is already utilized in this part of the valley, that, even by the construction of these large reservoirs, the new supplies made available would be sufficient to serve the normal growth for only a few years. However, they could temporarily relieve the stress caused by the overdraft on underground waters in the southern half of the valley.

The construction of these reservoirs would accomplish more than the development of some additional water and the delivery of completely controlled supplies. A very considerable amount of power could be generated as well. In order to generate the largest amount of power possible with an economic installation, the coordinated plan proposes that about one-fifth of the peak irrigation demand on the area served directly from the reservoirs, be supplied by pumping from the underground basins. By so doing, the draft of the reservoirs would be more nearly constant throughout the season and a greater output of salable power could be generated. Also, by pumping still greater volumes of water from the underground basins during years of subnormal run-off, completely

regulated supplies could be delivered to the land with smaller reservoirs than otherwise would be needed. The coordinated plan proposes that this be done to the extent that the total cost of completely regulated supplies would thereby be reduced. An exceptional opportunity exists for an economic arrangement of this character, for one-half of the area now receiving water from the rivers through canals is already equipped with wells and pumping plants.

These same reservoirs could easily be used for controlling floods. Their capacity would be sufficient, if operated under the plan herein proposed, to reduce floods to one-half their maximum flow without interference with their conservation functions.

No Conflict in Plans

Plans for constructing storage reservoirs on the Upper San Joaquin, Kings and Kern Rivers, the largest streams of the southern San Joaquin Valley, are now being perfected by water-storage and conservation districts. These are organizations of the many corporate units that now utilize water from these streams or desire to do so. The coordinated plan in no way conflicts with the plans of these districts. It is distinguished from them in providing for a more complete development than the studies of the districts indicate are desirable if the entire costs are assessed against the lands within the projects. The coordinated plan sets forth greater accomplishments for public consideration.

A series of trunk canals is included in the comprehensive plan for the ultimate development of the San Joaquin Valley. These canals would extend southerly, one from each main tributary of the San Joaquin River and one also, from the American River in the Sacramento Valley. They would divert at the highest practical elevation on the edge of the valley floor that would not involve expensive foothill construction. The function of these canals would be to feed the water from each tributary into systems of distribution canals at the highest possible elevation. This would take water now used in one system and deliver it to another system further south upon receipt of an equivalent amount from some other source. No exchange of ownership in supplies is suggested. Following this system, the entire valley floor may ultimately be brought under irrigation with the maximum economy in pumping the new supply imported from the Sacramento Valley. Even with this economic arrangement, the pumping lift on much of the imported water that ultimately will be required to irrigate the entire valley floor, will be large.

Only two of these trunk canals will be needed for some time to come.

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WATER PURIFICATION

Chlorine Economy and Chlorination Efficiency in Sterilization

By EARLE B. PHELPS*

FOR the production of the desired efficacy of chlorine in water sterilization a trace or more of residual chlorine as determined by the orthotolidin test is essential. The period of contact between the water and the chlorine is relatively unimportant provided the proper quantity of residual chlorine is maintained in a relatively clean water after a contact period of ten minutes.

Substitution compounds formed between the chlorine and organic matters in the water may produce a sterilizing effect upon effecting long periods of contact. When such compounds are formed and great length of storage is available, residual chlorine is sometimes unnecessary. The effect is similar to that obtained with chloramines. The more dependable procedure is to maintain a measurable excess of chlorine and thus insure a rapid removal of bacteria and algae. Thus also a "measuring stick" is available for sterilization efficiency control where residual chlorine test is applied.

Prevents Accidental Pollution

Residual chlorine in the water leaving the plant preventing "aftergrowth" likewise stands as a preventive against accidental pollution in reservoirs, and the mains following repair service.

In general, the greater soluble organic matter or ammonia content carried by the water, the greater the permissible residual chlorine content without taste and odor production. Also in organic waters the higher the residual chlorine content (within reason) the less likelihood there is of residual *by-product tastes* remaining in the water supplies to the consumers. Waters of extremely low organic or ammonia content may have a chlorinous odor with as little as 0.2 parts per million residual chlorine present. In chlorinating organic water the liability of producing an excess and consequently a chlorinous taste, is less to be dreaded than the by-product taste resulting from under-chlorination.

The rate of dissipation of available chlorine is governed to an extent of hydrogen ion concentration (pH value) of the water. In waters nearly void of bicarbonate and possessing mainly normal carbonates alkalinity will form hypochlorites which do not give up their available chlorine readily in the absence of hydrogenions. Softened water without recarbonation is thus likely to cause complaints due to failure of the available chlorine to dissipate in the pH medium.

Split Chlorination Popular

Chlorine by-products resulting from chlorination of waters containing dead vegetable matters may be destroyed with excess chlorine, i.e. super-chlorination.

Split chlorination wherein the raw water receives pre-chlorination and the filter effluent secondary chlorination is gaining prestige. The reduction of the bacterial load upon the filters, although the primary reason for pre-chlorination, is accompanied by other advantages such as operating economy. In split chlorination practice dual protection is afforded and with increasing pollution of the raw water supply pre-chlorination and dual chlorination are gaining greater recognition.

In sewage chlorination it is evident that the efficiency of the process is dependent upon maintaining excess or residual chlorine. The period of contact when residual chlorine is present is of secondary importance, not more than a ten-minute period being necessary. In the absence of residual chlorine, the bacterial efficiency is low. Long contact periods have some merit when the chlorine dosage is barely less than sufficient to produce residual after ten-minute contact. Without residual chlorine tests being systematically made there is no "measuring stick" available to apply to the process except the bacteriological tests. In the absence of residual chlorine such must be made immediately following if misleading results are to be avoided. The long contact period in the sample bottle has an effect which does not exist at the treating plant and apparent reduction in bacteria is not obtained similarly in the plant effluent subject to less period of contact before discharge.

Chlorine Demand Variable

The chlorine demand of sewages is quite variable. This is not alone true for various sewages, but the demand varies materially for a particular sewage effluent at various seasons of the year. Frequently the demand in summer is double that observed in winter. Septic sewage and particularly when the carriage water initially contains appreciable sulphate content has a considerably higher chlorine demand than fresh sewage.

Odors from sewage effluents are destroyed through addition of chlorine which combines directly with the odor producing matters, such as hydrogen sulphide. The decay and subsequent odor production in sewage may be appreciably reduced or eliminated if chlorine is applied early in the life of the sewage. Less chlorine than required to produce residual chlorine retards septization and odor production markedly.

In pre-chlorination of crude sewage the solids play a very limited role in the chlorine demand. Residual chlorine in crude sewage remains but little diminished after several hours' contact unless further breaking up of the solids is had during the contact period.

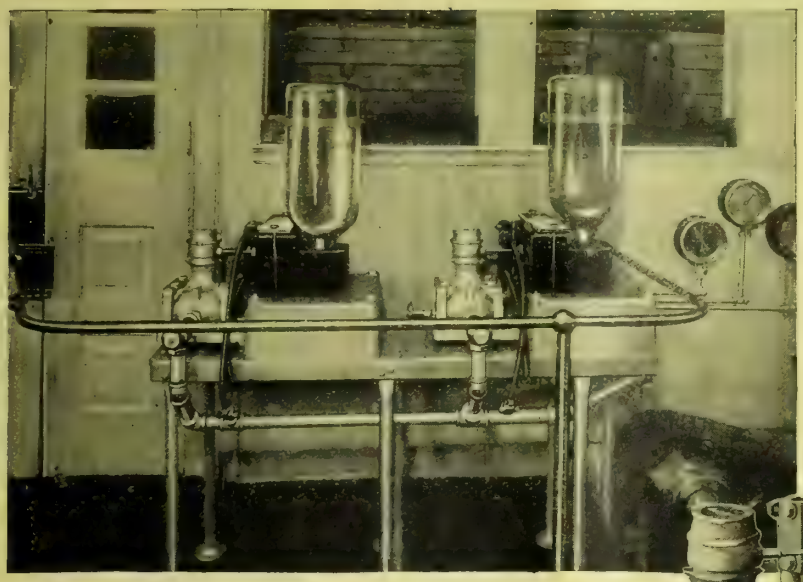
Chlorine demand of sewage is influenced by an increase or decrease of the pH value above or below the neutral point, pH 7.

Sure Performance Index

Chlorine as a result of its direct combination with organic radicals to form substitution products, rather than oxidization products of the organic matter in solution or pseudo solution, reduces the potential power of sewage to decay. The bio-chemical oxygen demand is reduced as a result of chlorination. This reduction is permanent or *actual reduction* as contrasted with temporary reduction or delayed oxygen demanding power previously considered to be the case. Such decrease in oxygen demand is observed well ahead of satisfactory disinfection, or the presence of residual chlorine. For maximum reduction, however, chlorine sufficient to produce residual is requisite. The reduction of the 24-hour oxygen demand is approximately one-half that of the five-day demand reduction.

The residual chlorine control test being simple, is applicable to the smallest or the largest sewage plant. It is the only sure index of continuous performance and indicates simultaneously optimum disinfection and oxygen demand reduction of the effluent. Its use is productive of chlorine economy and chlorination efficiency.

Extracts from a paper, presented before the Boston Society of Civil Engineers.



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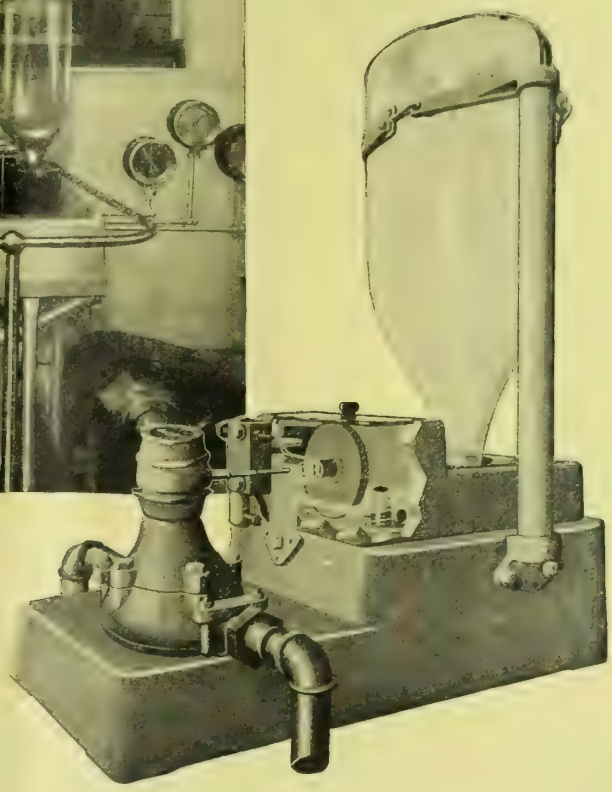

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New Water-Treating Processes Influence Factory Sites

Every manufacturing establishment requires a water supply, but the needs as to quantity and quality vary greatly, according to a report just issued by the Geological Survey, Department of the Interior. Practically all of the early industrial activity in this country was in places where the natural waters are soft and clear. Manufacturing has followed the spread of population to the West, but not uniformly, for some industries have grown up around centers far from the coast, while others have expanded where they were originally established.

The latter class, it is stated, contains most of those which require soft water. The process for softening water by exchange silicates, introduced comparatively recently, it is pointed out in the report, now makes it possible to locate such plants at places where they could not be operated successfully if they were to depend on the available water supply either in its natural state or after softening by the older methods.

Quality Requirements

Water supply must of course always be considered in locating any plant, and in some industries, like the manufacture of paper or textiles, it is likely to be the most important consideration. A factory for the manufacture of clothing or of cigars may require little more water than used for the individual needs of the workers and for cleaning workrooms; but a textile mill in which dyeing is done may use several million gallons of water each day.

The requirements as to quality of water also vary widely. Water used for cooling at steel plants or in some type of condensers at a power plant may be of almost any quality if it is not acid; but feed water for steam boilers should be either moderately free from suspended and dissolved mineral matter or easily made so. A paper mill that makes brown wrapping paper can use water of much poorer quality than is needed for a mill that makes fine white paper; but a plant that makes chemicals or drug products is forced to use distilled water almost exclusively in its manufacturing processes. Again, in certain activities the sanitary character of the water is the controlling factor.

Copies of Water Supply Paper 559 may be secured from the Superintendent of Documents, Washington, D. C., for 15 cents each.

Burton Lowther, consulting engineer of Denver, Colorado, has been retained by the city of Colorado Springs to report on the sanitation of the municipal water supply.

A. W. W. A. Nominating Committee Announces Selections

Gibson to Head Association If No Other Nominations Are Filed; Pracy California Trustee; Convention News Given

In accordance with its constitution the nominating committee of the American Water Works Association, has selected the following nominees for the various offices to be filled at the Chicago convention for 1927-28. In case no other independent nominations are filed, as provided for in the constitution, the report of the nominating committee will be considered as an election.

GEO. W. PRACY

President: James E. Gibson, Manager and Engineer, Water Department, 14 George St., Charleston, S. C.

Vice-President: William W. Brush, Chief Engineer, Department of Water Supply, Gas and Electricity, 2456 Municipal Bldg., New York, N. Y.

Treasurer: George C. Gensheimer, Secretary, Commissioners of Water Works, Erie, Pa.

Trustee, District No. 4: Seth M. VanLoan, Deputy Chief, Bureau of Water, 709 City Hall, Philadelphia, Pa.

Trustee, District No. 8: Louis R. Howson, Messrs. Alvord, Burdick & Howson, 1417 Hartford Bldg., Chicago, Ill.

Trustee, District No. 9: George W. Pracy, Superintendent, Spring Valley Water Co., 425 Mason St., San Francisco, Calif.

The next annual convention of the association is to be held in Chicago during the week of June 6th, 1927, at the Hotel Sherman.

At a meeting of the executive committee held recently in New York City, the publication committee's report showed that a very complete and diversified program of papers had been obtained, and that particularly interesting round-table discussions had been planned by the various divisions.

The entertainment part of the convention, as already arranged for, will equal, if not excel, that provided in any previous year, and the manufacturers promise a bigger and better display of exhibits than ever before.

Pump Agreement Fair to All

(*Continued from Page 24*)

a distinct step forward as compared to present day practice.

Under *paragraph ten,* providing for the tests, it is specifically stated that the buyer must, if he wants a test, call for it within 10 days after notification that the machinery is ready for operation. At the present time, the usual practice is to run a pump until about the time that a payment is due and then claim that the pump is not operating in accordance with his guarantee. In sandy country, this may well be true. Abrasion from sand or gravel, such as is given forth in varying quantities by practically every well in California, will cause a decrease in pump delivery, and consequently a decrease in efficiency. It, is not fair, however, to ask the pump manufacturer to assume the liability for such normal wear, and as a matter of record the manufacturers have agreed that within 10 days' time, the pump should be operating in accordance with its guaranteed performance and will assume up to that length of time the responsibility for such performance, unless there has been excessive abrasion or there is some external cause which prevents the pump from operating as specified.

Fair to Both Sides

It is felt that this is a fair proposition and that it is unfair for the buyer to use as a pretext for non-payment, in accordance with terms of contract, the fact that the pump does not seem to him to be operating in accordance with its guarantee.

Under this same paragraph it is certainly a decided advantage to the pump manufacturer to have a list of testing engineers, because they know that any one selected from this list by the buyer is competent, whereas at the present time the buyer will have fairly complete confidence in any incompetent engineer, who may make a test at his request, particularly if the engineer's report coincides with the buyer's wishes.

Under *Paragraph fourteen,* it is provided that insurance on the machinery shall be maintained by the buyer in favor of the seller, until payment in full has been made.

Briefly, in summarizing this contract form, it is the writer's feeling that the purchaser gains very materially as compared to the present form, by reason of the guaranteed performance made to him and by reason of the proper method of test that is provided; while the seller is also in an improved position because, with the new tests specified, it will not be possible for the purchaser to refuse to make payment in accordance with terms of the contract and aver as an excuse therefor the non-performance of the pump. As pointed out, such non-performance must be called to the attention of the seller within 10 days from date of installation.

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SEWAGE DISPOSAL

Los Angeles Sanitation Districts Nos. 2 and 5 Finally Get Outfall Sewer Permit

Disposal Will Be Made 4000 Feet Southerly from the San Pedro Breakwater; Right of Way Problem Remains

By R. F. GOUDEY

Resident Engineer, State Board of Health, Los Angeles

SANITATION Districts Nos. 2 and 5 of Los Angeles County, covering the principal portions of the southwest section of the county, exclusive of Los Angeles, were formed about three years ago for the purpose of providing for a trunk line sewer to the ocean. Two years ago these districts voted $9,120,000 for main trunk sewers. Two months after the bonds carried, the districts made application for permit to the State Board of Health to dispose of sewage, after screening, into the Pacific Ocean at White's Point, and 2,260 feet from shore.

Objection immediately arose from residents in the vicinity of White's Point and in San Pedro. In an effort to dispel this opposition, the sanitation districts employed X. H. Goodnough, chief engineer of the Massachusetts State Board of Health, who advised against the outfall as originally planned at White's Point, recommending that the outfall be placed at a point one thousand feet east of White Point and extending southeasterly instead of southwesterly for a distance of four thousand feet from shore. His alternative suggestion was for a similar outfall at the foot of Pacific Avenue, Point Firmin.

Make New Application

This report failed to gain the confidence of the people of San Pedro, and the San Pedro Chamber of Commerce employed Professor Charles G. Hyde of the University of California at Berkeley, who made a very intensive and exhaustive study. He recommended against either White Point or Point Firmin, because the distances proposed were insufficient to protect the shore line for recreational purposes. His solution was a line in the center of the geographical area to be sewered, extending 17,500 feet from the present shore line at Terminal Island virtually between Long Beach and San Pedro.

The sanitation districts, on April 27, 1926, amended their original application of April 4, 1925, to include an outfall near White Point or at Point Firmin as recommended by Mr. Goodnough, but the State Board of Health, after several hearings and the receipt of Professor Hyde's report, advised that it would probably deny the permits as applied for, and the sanitation districts responded with a new application on December 1st, 1926, to dispose of sewage five thousand feet off shore at or near White's Point.

This new application really followed on the heels of a report by the Los Angeles Chamber of Commerce recommending that the outfall be placed either at White's Point five thousand feet from shore, in the vicinity of the line recommended by Mr. Goodnough, or a line which would follow along the breakwater and leave the breakwater so as to terminate eight thousand feet from shore and two thousand feet from the breakwater. This report recognized that the State Board of Health, if it granted a permit at White's Point, would probably have to require additional treatment or extension in the near future.

Permit Granted January 15, 1927

The State Board of Health then denied the new application for an outfall at White's Point and ordered Sanitation District No. 2 to renew an application and ordered the change of the proposed place of disposal for an outfall in the location recommended by Professor Hyde, or from the breakwater as recommended by the Los Angeles Chamber of Commerce. The sanitation districts then lost no time and made a fourth application for permit to dispose of sewage after screening into the Pacific Ocean at a point four thousand feet southerly from the San Pedro breakwater and nine thousand feet from the nearest shore at Point Firmin. The State Board of Health granted this permit on January 15, 1927.

The conditions under which the permit was granted to the sanitation districts are as follows:

1. Release or overflow of sewage inland or into inland waterways shall not be permitted except with the special consent of the State Board of Health, and extension of sewer capacity necessary to guard against violation of this condition shall be undertaken sufficiently in advance of need to prevent occurrence of overflows contrary to this condition.

2. Odors, flies and other menace to health from the operation of screening and treatment plant shall be prevented and controlled.

3. Construction shall be reliable and secure insofar as nuisance and menace to health are concerned, and that the Board may be adequately assured thereon working or other detailed drawings, specifications and descriptions shall be furnished upon request.

4. Garbage, fecal matter, solid matter or oily sleek, recognizable as of sewage origin from said district, shall not be visible at any beaches, shores, fishing or pleasure piers or breakwaters. The quality of water at points which in the absence of the sewage of said district would be safe and suitable for public bathing purposes, shall conform to the bacterial standards for salt water bathing beaches, as may be established or modified from time to time by this Board.

5. It is understood that additional treatment works, changes in outfall, and, or, improvements in operation shall be provided when required by the State Board of Health.

Probable Future Polluted Areas

In determining the proper distance which the outfall should be constructed from shore, the State Board of Health was guided entirely by the results of five surveys made at Hyperion, where sew-

PREDICTED BEHAVIOR OF SEWAGE DISPOSED OF AT WHITE POINT AND POINT FIRMIN OUTLETS

Poulation served	Acreage contaminated in excess of 10 B. Coli per c.c.	Acreage per M. G. D.	Ordinary daily travel of cont. 10 B. Coli per c.c.	Max. travel from Hyperion evi. 1925
500,000	500	10	2700 ft.	4300 ft.
1,000,000	700	7	3200 ft.	5000 ft.
2,000,000	1200	6	4200 ft.	6500 ft.
3,000,000	1500	5	4700 ft.	7300 ft.

age from a million people of Los Angeles, after screening, is discharged into the ocean 5,280 feet from shore into sixty feet of water. It was found that tidal, wind, current and temperature conditions did not vary materially from those which existed at any of the other proposed points of disposal.

Similar tests to determine the area of bacterial pollution have been made by the State Board of Health at Santa Barbara, Ventura, Santa Monica, and Venice. These cities gave information only for populations varying from ten to thirty thousand. These results, in addition to exterpolated figures for greater populations, are given in the table.

Will Serve 1,800,000 People

A factor of safety was added at the breakwater outlet because the proposed Cabrillo Beach lies between the root of the breakwater and Point Firmin. With the outfall only four thousand feet from the breakwater, heavily polluted areas will exist along the breakwater which might drift toward the proposed Cabrillo Beach. It was also thought essential to carry the outfall to the bend on the breakwater before leaving it. These factors combined gave a final distance from shore of nine thousand feet.

It is believed that the outfall sewer as now designed and planned will adequately serve 1,800,000 people without causing any objectionable pollution at any proposed recreational developments along the coast line at San Pedro. Moreover, the discharge of the sewage from the proposed outfall will in no way menace, aesthetically or actually, the beaches as they exist at Long Beach and along the Orange County shore line.

The sanitation districts then made application to the City of Los Angeles for a right of way for the breakwater line. This right of way was formally denied by the City Council on February 9, 1927. It is quite probable that the districts will now resubmit an application for permit and a request for rights of way for a line at White's Point and will exclude from it San Pedro, Wilmington, San Gabriel Valley cities and the Whittier district, and thereby limit the population which will be ultimately sewered at that point to the ocean. Since there has been considerable criticism by Long Beach and San Pedro for additional treatment other than fine screening, and since the cost of ocean outlets at White Point in deep water is unduly expensive, it now appears feasible to provide plain sedimentation with separate sludge digestion, with a much shorter outfall and still protect the shore line. This is in line with the ideas expressed by the Los

(*Continued on Page 57*)

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Fig. 200

Fig. 180

Fig. 40

Fig. 41

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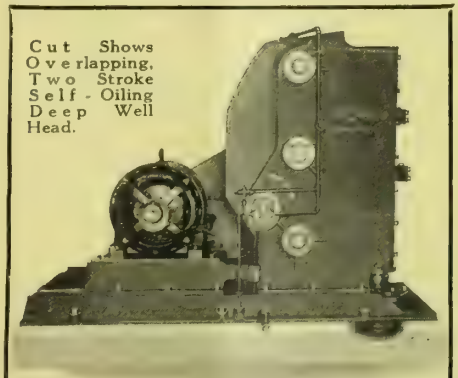

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Better Irrigation Financing Is Urgent Need

(*Continued from Page 11*)

which, on the other hand, may be quite economically proper from a governmental and community standpoint. These projects, it seems to me, must, as time goes along, be undertaken either by national or state agencies, and the financial burden involved in them must not and should not be put altogether upon the tiller of the soil. We have examples of such projects in the Boulder Canyon dam and the equalization of the stream flow of the Sacramento River which latter project must necessarily be accomplished if our two great valleys are to continue to prosper and grow agriculturally.

We have but to mention the financing of reclamation districts in California, when there comes into the minds of any one who has had connection with such districts—the word "warrant." The reclamation warrant, except in a few favored sections, does not, today, have an enviable reputation among the financial institutions of California. While it has been customary for both irrigation districts and reclamation districts to issue warrants without funds on hand to meet such warrants the laws creating the two forms of organization differ greatly as to repayment of such obligations.

The irrigation district law requires that, each year, assessments be placed upon lands of the district sufficient to meet all outstanding warrant indebtedness—and in all properly functioning districts, at the present time, this is being done with the result that, when such warrants pay their calls, as they frequently do upon the banker, they do not outstay their welcome.

These Warrants Not So Good

The reclamation law, on the other hand, does not have similar provision for establishing a due date and warrants issued must often await the placing of an assessment upon the lands of the district which, at the time of the issuance of such warrants may not as yet have even been commenced and thereafter must await the collection of such assessment. As the placing of an assessment is often a complicated affair and subject to many legal delays and re-submissions to Boards of Supervisors, we find the reclamation warrant long overstaying its welcome with the banker in many cases.

Because of this uncertainty as to the date of payment, we find warrants issued by most reclamation districts salable only at heavy discounts. This practice of discounting warrants may not work any great hardship where the number of landowners in a District is small, as the warrants are then often sold to the landowner more or less proportionately and held against the payment of his assessment. In the larger districts, however, such discounting of warrants means to the average landowner inevitably an increase of his financial burdens. This form of financing undoubtedly grew out of the necessities surrounding the protection of levees along the rivers where large expenditures could not wait on orderly procedure. However, there is no doubt but that a method of financing, which heavily discounts the paper of a district and then adds compounded interest at 7 per cent of its face value over an uncertain period of years, has done much to discourage the landowner on some of the most productive lands of our state.

System Causes Big Loss

Within the confines of the Sacramento-San Joaquin Drainage District, it is estimated that there has already been spent some $72,000,000 largely under these conditions, and outside of that district, it is probable that another similar sum has been spent—making in all some 130 or 140 million dollars spent under a system of financing which causes a heavy discount and a maximum rate of interest in the money marts. It would seem that self-interest of those owning land within reclamation districts would dictate some change in the law, giving a more definite due date on papers issued by such reclamation districts, and in that way create a more favorable impression among the investors in such securities.

It is not at all unusual in reclamation districts to find the following procedure in the doing of very large constructive works:—First, an engineer's estimate is prepared, which is adopted by the board and receives the necessary endorsements of the reclamation board and board of supervisors; then without first raising the money by cash assessments or bond issues, work is started and, in some cases, several millions of dollars of constructive work done under the above system of a discounted warrant and without the landowners—who have ultimately to pay the bill—having had any opportunity to make known their desires in the matter. This work, in some cases, is entirely completed before the assessors have even placed upon the lands assessments based upon benefits to be derived from such work. The first opportunity the landowner is given to make any objection is when he finds the money already spent and he is called upon to defend his assessment before a board of supervisors. After this, he has the choice of either paying in cash his assessment—which is usually too

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high for the ordinary farmer to pay out of current revenues—or voting for a bond issue based on such assessment upon his land. Here again is a chance for an additional discount in the selling of such bonds and a further burden placed upon the lands.

Change in Laws Necessary

The law should, I believe, be changed in this respect—putting some limit upon the trustees of reclamation districts in the expenditure of money ahead of the raising of such money. This change must of necessity be done carefully in order not to embarrass the districts where emergencies arise in which money must be spent rapidly to avoid great damage. Should such a change be possible in the law—and I believe it is—it would do more than save the landowner the heavy discount and interest charges which I have already pointed out. In addition to this it would provide for doing the work in his district on a cash basis and any one who has been connected with such work realizes that contract prices are considerably lower where cash has been made available for doing the work.

The irrigation districts of the State—of which there are now 90 in active operation, comprising an acreage of 3,583,284 acres—have to date voted $135,000,000 in bonds, which money has been spent or is being spent in constructive irrigation works. While it cannot be claimed that the irrigation district law is a perfect one from a financial standpoint, the results of their operation can be pointed to with some considerable satisfaction by our State.

Contrary to results often employed by the reclamation districts, this sum of 135 million dollars has, to a very large extent, been spent only after the bonds have been sold and the money in hand to pay for the work to be done. Although I have not the figures necessary to prove the contention, I doubt if it can be denied that these irrigation districts have obtained a larger amount of work done per dollar expended than have the reclamation districts under their form of financing.

A Good Record

The present California Irrigation District Act came into being in 1897. Since that time some 110 districts have been formed—90 of which are now active. The inactive districts, with an area of 332,468 acres, have no bonds out against them. The active districts with 135 million dollars' of bonds, show a very high percentage of successes. Out of the 3,500,000 acres included within their boundaries, some 100,000 have had difficulties and have defaulted to some extent in their payments. This, as may

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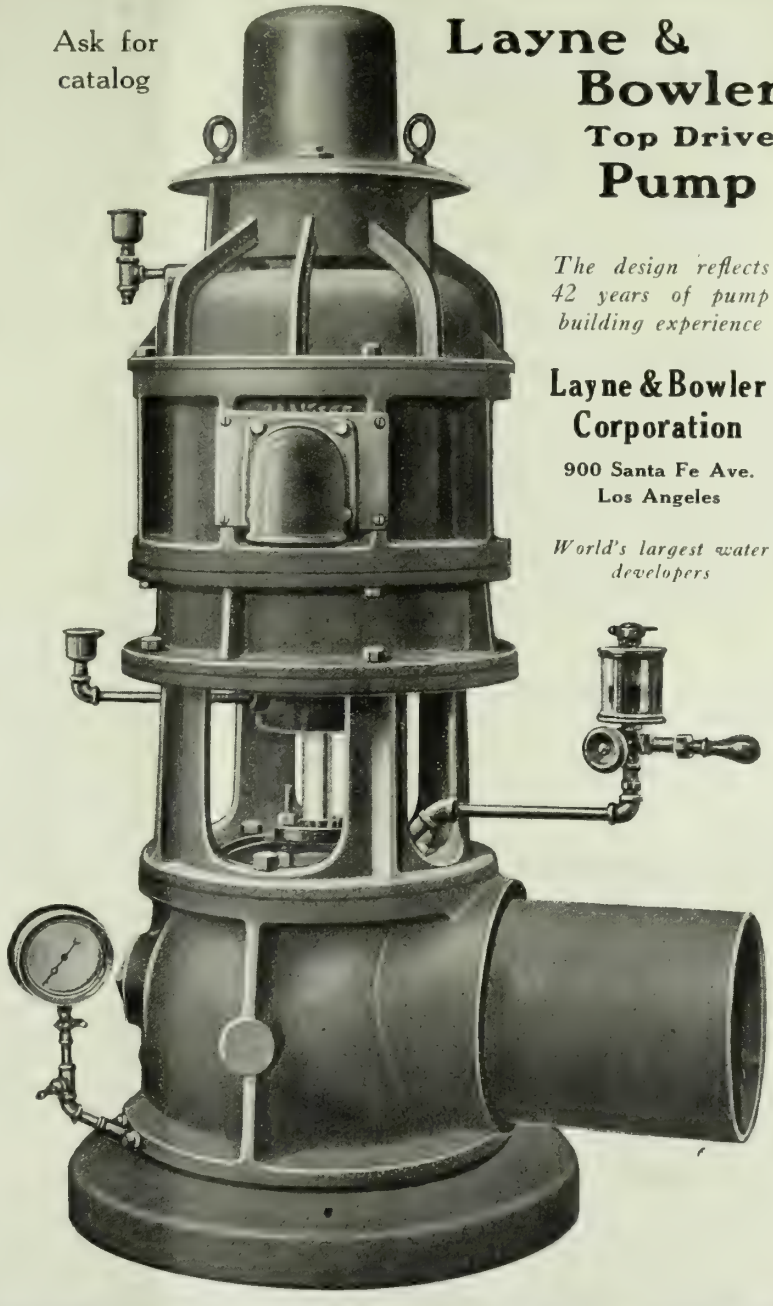

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be readily seen, is a very small percentage of the whole and ranks high when we consider other bond issues, whether they be by railroads, public utilities or industrials.

It is believed by those who have followed carefully irrigation district financing, that the bonds of irrigation districts —and I believe this should apply also to reclamation bonds—should command a higher price and a lower rate of interest in the money market than they do. In order to accomplish this greatly to be desired result, some few changes will probably have to be made in the law itself. At the present time, there is not a proper provision for winding up or straightening out the affairs of defunct or defaulting districts. The investor in bonds wants to know, first, that his money has ample security back of it; and, in the second place, should difficulties come, he desires proper provision made by which his money can be refunded to him through the sale or control of the assets back of his bonds. It is believed that this detail can be worked out, and, at the present time, the Irrigation Districts Association of California has a committee working upon the matter.

State's Attitude A Handicap

Another matter that is holding back the price of irrigation district bonds is the attitude of the State itself toward them. Under a provision of the law, when irrigation district bonds are issued, the district issuing such bonds may apply to a Bond Certification Commission composed of the State Superintendent of Banks, the Attorney-General, and the State Engineer, to certify such bonds as proper investments for saving banks, trust funds, et cetera. This function is an important one and of necessity great care should be used that only the bonds of such districts are certified as have been organized under proper economic conditions. It is possible that some change should be made in this phase of the law, requiring some more careful investigation than perhaps has been made in the past before certification. The individual investor can not of necessity know the details about the irrigation bonds in which he is investing and therefore must rely upon the Certification of the Commission in making his investment. Also, it would seem that when such certification has been made by duly authorized officers of the state, the state itself, without question, should accept such bonds as security wherever municipal district bonds are called for. If this were done and the state stood squarely back of its own act in certification of such bonds, a very greatly increased market would be had for these bonds, as the banks of the state are large purchasers of the bonds which they use in protecting deposits of state and county moneys. I regret to have to say that this state has not, in all cases, taken the broad point of view that it should in these matters and has given marked preferment to municipal bonds even though in some cases the municipality issuing such bonds is wholly within an irrigation district over the irrigation district bonds themselves.

At the present time, the halls of Congress and the columns of our daily papers are filled with discussions of various plans to rescue the farmer from the serious plight in which he now finds himself. The better financing of our irrigation and reclamation institutions, while it is not a cure-all for our agricultural troubles, is desirable and should receive the serious consideration, both of our legislators and of our landowners who, under present conditions, ultimately pay the bill and will continue to do so until they find a way, as have our public utilities and trust controlled industrials, to pass extravagances and mistakes on to the consumer.

W.I.E.A. Meets in Los Angeles

The Western Irrigation Equipment Association held its quarterly meeting in Los Angeles, January 28th. The morning and afternoon sessions were given over to the transaction of business. The progress of the association was reviewed by the members and a future program outlined.

In recognition of the work performed by Professor Ben D. Moses on the committee on Standardization of Irrigation Equipment, and by virtue of his being project director and secretary of the California Committee on Relation of Electricity to Agriculture, the members of the association unanimously elected him to the third honorary membership.

The evening session was a banquet at the Commercial Club, and was well attended. President Cox presented to the Association a new gavel which is in the form of an impeller, and the old gavel, a hatchet, was "buried" with the proper ceremony.

Addresses were given by Honorable John W. Kemp, who spoke on Co-operation; Professor R. W. Sorenson whose subject was "Electric Motors" and Professor R. L. Daugherty, who gave a resume of his recent activities in the American Society of Mechanical Engineers, and his trip through the east, while attending the recent convention of that society. The next meeting of the W. I. E. A. will be held at Fresno, April 15th, 1927.

The July meeting of the association will be held in conjunction with the California Concrete Pipe Manufacturers Association, in San Francisco on July 15.

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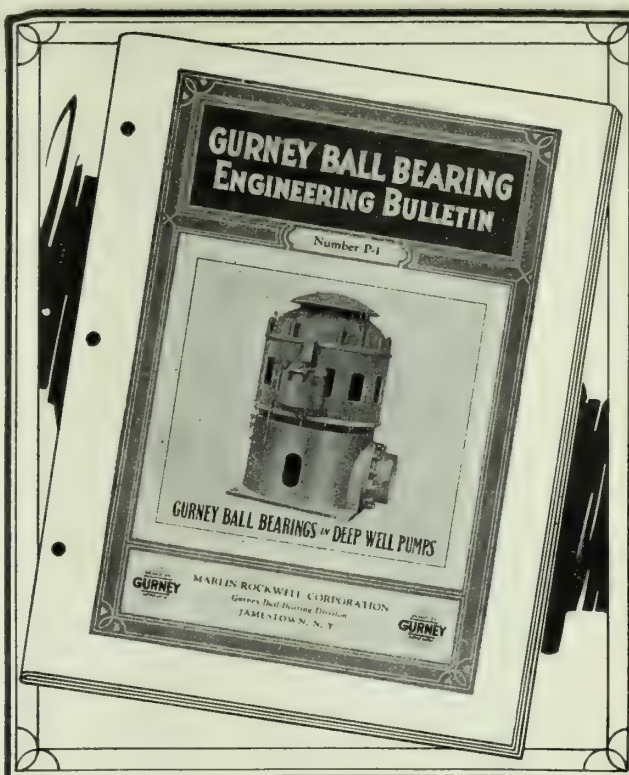

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LEGAL *and* JUDICIAL

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Irrigation District Directors Are Public Officers

The provisions of the Penal Code of California are held applicable to irrigation district directors.

Certain accusations were made against a director of the Imperial Irrigation District and the same were set down for trial by the Superior Court. The charges were the improper allowance of claims, the improper incurring of indebtedness and the improper payment of expenses. The fight seemed to be centered on the use of district money to arouse public opinion in favor of the Boulder Canyon project.

The defendant files a petition in prohibition to prevent the trial of such charges, alleging that the complaint does not allege facts sufficient to constitute a cause of removal under Section 772 of the Penal Code or Sec. 73 of the California Irrigation District Act.

The Court in denying the writ (Rose vs. Superior Court etc. 52 Cal. App. Dec. 225; Jan. 21, 1927) states:

"Petitioner's . . . . contention is that a director of an irrigation district is a state officer and not a district officer, and being such the Superior Court has no jurisdiction to entertain the accusation under Sec. 772 of the Penal Code . . . . It is apparent, we think, that an analogy cannot be drawn between bank commissioners whose activities and powers are state wide and directors of an irrigation district confined to a particular district. Nor do we think it is significant that they are not strictly political subdivisions. The directors are elected by the qualified electors and voters of the irrigation district and are responsible to, and answerable to, the voters of that district for a proper discharge of their official duties. It would be a strained and wholly unjustified construction to say that such officials should not be answerable to the voters of the district the same as officers of a municipality or other political subdivision. The clear legislative intent was to protect the public against derelict officials performing their duties within the county in which the Superior Court sits."

In explaining the use of the term "public officers of the State," as used in various decisions of the Supreme Court, the Appellate Court says:

"Therefore, in using the words 'public officers of the state,' the court intended to convey the meaning that they were public officials, and in that sense every public official, whether of a municipality, county, district or state, be his duties of great or minor importance, is a 'public officer of the state.' This is but another way of expressing what was also said by the court in that case (In re Madera 92 Cal. 296). 'Its' (the district) officers are public officers, chosen by the electors of the district, and invested with public duties.' Sec. 889 of the Penal Code must be construed with Sec. 772 of the Penal Code, but when the word 'District' is used in Sec. 889 of the Penal Code, it is descriptive of a geographical part of the state and it may be a school district, an irrigation district or any other district to which has been entrusted the discharge of certain public duties for that particular district."

The Court also holds that the provisions of Sec. 73 of the Irrigation Act are not exclusive and that proceedings could be brought to remove directors under this section or under the Penal Code.

Reaffirms Old Riparian Theory of California Waters

Supreme Court renders decision which affects future water storage for irrigation and power.

In the case of Herminghaus vs. Southern California Edison Company, et al., 73 Cal. Dec. 1 (Jan. 4, 1927) and in which a rehearing was denied, the Supreme Court of California re-affirms the old but important case of Lux vs. Haggin, 69 Cal. 225, and holds:

"That the rights of the riparian owners to the use of the waters of the abutting streams were paramount to the rights of any other person thereto: That such rights were parcel of the land and that any diminution of the stream against the will of the riparian owner by other persons was an actionable injury."

The case had received widespread attention with a great galaxy of amici curiae appearing, and a determined effort was made to have the Supreme Court distinguish the Lux v. Haggin Case and establish a rule of "reasonable use" as against riparian owners as had been done in the State of Washington. The Court, however, clung to the older theory that the right of the riparian owner to the use of water "was a right of property, a parcel of the land itself." In answer to the plea of "public policy" it states:

"Public policy is at best a vague and uncertain guide, and no consideration of policy can justify the taking of private property without compensation."

The result of the affirming of the judgment of the lower Court is to prevent the storing of winter waters by the Power Company and the granting to the riparian owners the right to use such waters for winter flooding and deposit of silt, although ninety-eight per cent of the water must, of necessity, be wasted.

In an attempt to limit the right of a riparian owner to a reasonable, non-wasteful use of water, the legislature is now considering two constitutional amendments having that idea in mind. Various committees have been created by bodies interested in the problem such as the Irrigation District Association of California, which are assisting in formulating an amendment which will protect the riparian owners but allow waste water to be put to work.

Irrigation District Given Increased Authority

Employment of a legislative agent by an irrigation district not unlawful.

A decision of extreme interest and importance to the irrigation districts of California was rendered by the California Supreme Court on January 31st, 1927, in the case of Crawford vs. Imperial Irrigation District et al, 73 Cal. Dec. 159.

The Imperial Irrigation District had employed one B. F. Fly to appear before Congress and its Committees to present the district's case concerning the Boulder Canyon project. A property owner brought a suit in the Superior Court to enjoin the payment of such compensation on the grounds that expenditures for this purpose were unlawful and beyond the powers of an irrigation district. The lower court granted the injunction and an appeal was taken to the Supreme Court.

In reversing the trial court and holding that such expenditures were both proper and within the powers of the irrigation district, the Supreme Court states:

"The employment of persons to influence legislation, or to influence decisions of the land department, or even the decisions of judicial tribunals, in a proper way, is not against sound public policy. A distinction is drawn between the use of personal, or any secret or sinister, influence upon legislators, by one who seeks the passage of an act, which is contrary to public policy, and the open advocacy of the same. It is generally agreed that the appearance of a representative of an interested party before a public body to urge the adoption of a particular measure or policy is neither illegal nor improper when the means employed are open and have for their purpose the pre-

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THE NEW RUTH DREDGER digs successfully in either dry or swampy ground. With its quick adjustable elevator, operating from either side of the dredger and its high speed endless chain of automatic self-emptying buckets and consequent uninterrupted flow of dirt, and ease of mobility, it operates at a minimum cost per cubic yard or lineal foot, heretofore considered impossible.

The RUTH cuts smooth even banks and bottoms—cleans canals, whether empty or filled with water, of all muck, sand, tulles, small willows and water grasses.

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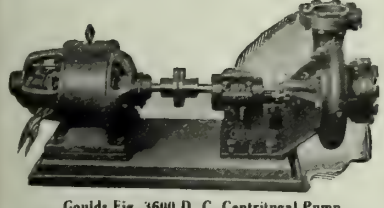

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Fig. 134—Casing Plug

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Advantages of Metering Irrigation Water

1.—It provides an equitable and just basis for all water users on which to pay their portion of the cost of operating their canal system.

The farmer who uses less water by the meter system pays less in proportion than the farmer who uses more.

2.—It provides a means of knowing how much water is applied to a field or crop. The U. S. Department of Agriculture and State Experiment stations have many times shown that the quantity of water applied to a crop sensitively influences the yield. The Universal tendency and danger is to irrigate too heavily.

3.—It encourages the farmer to save water by better field and ditch preparation.

4.—It allows him to use as much as he likes and gives it to him when and as often as he wants it.

5.—It increases the water supply by eliminating wasteful tendencies.

6.—It creates better harmony among water users and co-operation between them and the canal operators by providing a fair and just means of measurement which is beyond dispute.

7.—It will often prevent the development of seepage lands due to the removal of extravagant irrigation practices among users on new projects. This saving is often many times the cost of a meter system.

8.—The general effect of metering irrigation water is to reduce the cost of canal operation, increase irrigation efficiency, stop complaints, create better crops, and avoid expensive drainage works.

9.—The metering of irrigation water pays big dividends to the irrigators from the day it starts and always keeps on paying.

10.—The principle is sound and is being widely adopted.

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sentation of the merits of the advocated matter. . . . ."

In referring to the powers of the Board of Directors to employ Fly, the Court says:

"We think it is plainly within the powers of the Board of Directors of said District to furnish to Congress all the information in its possession which might tend in any manner to enlighten the members of that body upon the pending bill, and if in the judgment of the Board of Directors this can best be done by having a representative of the district appear personally before the Committees of Congress, then in our opinion said Board of Directors is authorized to employ and send to Congress such representative . . . . a public officer or board has not only the powers expressly enumerated by law, but also those implied powers which are necessary to the exercise of the powers expressly granted."

Issue of Irrigation District Bonds In Exchange for Property Not Illegal

The burden is upon the district to show inadequacy of the consideration.

Although losing its importance as a precedent by reason of various amendments to the California Irrigation District Act since the acts were performed, a very interesting situation is presented in the case of Stowell vs. Rialto Irrigation District, 73 Cal. Dec. 118 (Jan. 17, 1927).

It appears that in 1890 the District entered into a contract with the Semi-Tropic Co. for certain pipe lines, rights of way and water. Bonds were issued by the District. Later the district refused payment of the interest coupons on the grounds that the bonds were not given for the purchase of property at par as required by the act, but were in fact given in payment for construction work. This point had been decided adversely to the district in 155 Cal. 215. The later suit to enforce payment of other bonds was brought on a second contract under somewhat similar conditions. The trial court denied a recovery to the plaintiff and in reversing the trial judgment, the Supreme Court holds:

"It is true that the exact figure at which the bonds were taken nowhere appears, but, in the absence of proof to the contrary, it must be presumed that official duty was properly performed and that the bonds were not negotiated at a figure which violated the provisions of said statute. . . . .

"Even if the bonds were promised in the first place by the irrigation district for construction work, the delivery of the bonds would not be rendered illegal if prior to such delivery the district had enacted and received a deed to property of the type allowed to be purchased under the statute and of a value equal to the par value of the bonds given in exchange; and this is true even though the property conveyed was the same as that upon which the construction work had been performed."

Prior Determination of Seepage Damage Is Final

A plea of res judicata can be raised on a motion for judgment on the pleading.

In the case of Pomponio vs. Larsen, 251 Pac. 534, (Colo.) a suit was brought by plaintiff to restrain defendant from operating two drains which emptied drain water on plaintiff's land. Defendant sets up in his answer that plaintiff had brought a prior suit on the same cause of action which had been decided in favor of defendant and that this judgment was a bar to the present suit.

In holding that this defense was good the Supreme Court of Colorado says:

"Plaintiff admits that there had been a controversy between the parties as alleged but denies the judgment and alleged the former action was for damages and not for equitable relief. . . . . To constitute a valid plea of res judicata, there must be identity of the subject matter, of the cause of the action, of the persons and parties, and in the quality of the persons for or against whom the claim is made . . . . The best and most accurate test as to whether a former judgment is a bar in subsequent proceedings between the same parties, according to the authorities, is whether the same evidence would sustain both, and if it would the two actions are the same . . . .

"Applying the foregoing principles to the case here, the conclusion is inescapable that defendant's plea of res judicata is good and the judgment of the trial court right . . . . The parties are the same, and the same evidence would sustain both actions. The relief prayed for in this proceeding could have been granted in the former action. The matters involved were not within the exclusive jurisdiction of equity. . . . .

"But plaintiff urges that defendant's motion for judgment on the pleadings was not proper . . . . In the circumstances of this case, the motion was, we think, properly sustained. Where the defendant pleads a former judgment in bar, the plaintiff must admit or deny the judgment or deny that it was for the same cause of action."

Idaho Ruling on Question of Ditch Ownership

To enjoin the present use of a ditch the burden is upon plaintiff to show lack of right in defendant.

In the case of Call et al. vs. Coiner, 251 Pac. 617, (Idaho), the plaintiff brings an injunction to prevent defendant from using or interfering with a certain ditch. In support of their case they introduce a deed showing a conveyance of lands "together with all water right, ditches. . . . ." No evidence was introduced to show that the grantors of plaintiffs were the exclusive owners of the ditch conveyed. Defendant on the other hand pleads and shows a use for a period of five years. The trial court in its judgment finds that:

"Plaintiffs had no right to use said ditch to the exclusion of defendant, but that plaintiffs and defendant were joint and several owners therein, each entitled to convey therethrough waters for the irrigation of their respective lands."

The Court also ordered measuring devices installed. Nominal damages in the sum of $1.00 was granted to plaintiff which was sustained by the Supreme Court for the reason that no evidence was introduced showing the amount of the damages but merely that "the crops were damaged."

On this point the Court states:

"Plaintiff had not pleaded destruction but only injury. The measure of such damages had been declared by this Court to be the difference in value of the crops before and after the injury . . . . There is no word in the record fixing or tending to fix the value of the crop after flooding . . . . The jury had either to guess blindly or award nominal damages, which latter they logically did."

California Districts Meet to Consider Needed Legislation

The Irrigation Districts Association of California, representing over three million acres of land, met at the Hotel Sacramento, Sacramento, Calif., on Wednesday and Thursday, January 12th and 13th, to consider needed legislation concerning irrigation districts. The executive and legislative committees had prepared various bills for consideration and discussion by the association as a whole.

Among matters of particular importance and interest to the districts was legislation providing for the reduction of penalties from 2 per cent to 1 per cent on delinquent assessments, the creation of machinery to create a local assessment district within an irrigation district to provide local laterals to be paid for in installments, the granting of the power to the Bond Commission to supervise the district proceedings in a defaulting district, with a state revolving fund to prevent defaults in bond interest and principal, and the elimination of the continuing right of the land owner to redeem the land after three years' default and granting the district absolute title to the land.

The recent Herminghaus decision reaffirming the strict interpretation of the Riparian Theory of the Lux vs. Haggin case was discussed and a committee consisting of Messrs. Wright, Hankins, Griffin, Dennett and Thornton was appointed to find legislative ways and means to meet the disastrous situation created by this decision.

All irrigation districts were well represented at the meeting by directors, officers and attorneys, the total representation at the session being something over 100 delegates.

The meeting was adjourned until the second session of the Legislature at which time all legislation that has been introduced will be further considered and either approved or disapproved.

Earl C. Pound, of Brawley, California, and Ira Aten, of El Centro, were re-elected directors of the Imperial Irrigation District from their respective divisions. T. W. Barry was returned as assessor and collector and F. H. McIver as treasurer of the district. None of these had any opposition.

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For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

OVERHEAD IRRIGATION

RECENT OVERHEAD INSTALLATIONS SHOW GOOD RESULTS

MANY sections of California are now using the overhead irrigation system to some extent and according to reports coming from the middle Sacramento and San Joaquin valleys, greater acreage is now being covered than ever before.

Edwin Hall, who has an alfalfa ranch near Fresno, California, is one of the latest converts, and is a good booster for the system. Some time ago, Mr. Hall had an overhead installation made on his alfalfa acreage, and the results far exceeded his expectations. The sprinklers were mounted about one hundred feet apart, and the pressure pumps delivered directly into the overhead piping system at fifty pounds pressure. In this particular instance the results were surprising, Mr. Hall writes, and he adds: "Up to the time the installation was made I had not been able to grow more than four crops a year. The first year with overhead irrigation, I cut nine good crops of hay, and this year (1926) I cut my tenth crop on November 20th. The cost of installation was more than paid for the first season by the increased yield."

Those familiar with furrow or grade irrigation, know that one side of a field may become very wet before the other side begins to get moist. If there are undulations, the field becomes a series of wet and dry spots, and if there are any gopher holes, a vast amount of water may be wasted. Overhead irrigation goes a long way toward eliminating these difficulties, as uneven topography does not affect the amount of water delivered to a certain point, and all of the ground is covered, so that, if the absorptive quality of the soil is the same, the penetration is uniform.

OVERHEAD SPRINKLERS INSTALLED 100 FEET APART AND WORKING ON 50 POUNDS PRESSURE

Note the absolutely uniform distribution and that the attendant can walk up to and adjust any sprinkler without getting wet; or close valve and move sprinkler to another location and set it in operation without getting wet.

Mr. Hall said his installation was made by the Buckner Manufacturing Company of Fresno, California, manufacturers of the "Overhead King" and "Golf King" types of sprinklers. This company states that the demand for overhead equipment is growing and that the success attending the installations in San Joaquin Valley sections is largely responsible.

The Albert M. Stevens Intermont Ranch in the foothill section near Los Angeles, has recently installed an overhead system made for them by Clarence H. Thomas of Los Angeles. This ranch, which comprises over 1600 acres of foothill land, has been using overhead irrigation on various sections of their acreage for some time. This last coverage was for ten acres, which makes a total of 86 acres on this ranch that are now covered by overhead irrigation. Gravity flow is available at 55 pounds inlet pressure, and there is 180 pounds pressure at the end of the system.

Clarence H. Thomas has also completed a nine-acre overhead installation for I. L. Noggle, whose ranch is near Ramona and Foothill Boulevard, Los Angeles County. This is the third installation made for Mr. Noggle during the past year. This system requires a booster plant, which was installed in this instance by the Fairbanks Morse Company.

Economic development of any kind always arouses considerable public interest, and such is the case with an overhead irrigation installation recently made near Riverside, California. Doctor Frank Grey, of Long Beach, is developing a small tract of land, putting most of it into fruit, and was confronted with the necessity of irrigation. He wanted a permanent installation, but did not feel that the cost of such was warranted at the present time, or at least until there was a return from the crops. Doctor Grey made an investigation of nearly every type of irrigation system, and finally decided upon an overhead system, which he thought would be best suited for his particular requirements.

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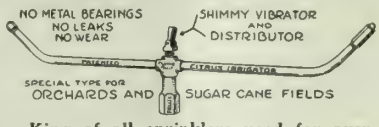

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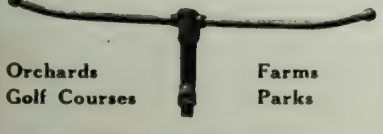

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SURVEY *of* HYDRAULIC DEVELOPMENT

As Shown by Official Records of the Month -- Local, State, and Governmental

Applications Filed

Among the more important applications for permit to appropriate water filed with the State Department of Public Works, Division of Water Rights, California, during the month of January, 1927, were the following:

Application No. 5325 (Butte County)—John C. Myers, c/o Seth Millington, attorney at law, Gridley, Calif., for 4.00 cubic feet per second from Drainage Ditch Rec. Dist. 833, tributary to Sacramento River. To be diverted in Section 6, T 17 N, R 2 E, M. D. M. for irrigation of rice; 160 acres. Estimated cost $1,000.00.

Application No. 5326 (Calaveras County)—Mrs. Sarah Arata, Comanche, Calif., for 0.002 cubic foot per second from Mokelumne River tributary to Mokelumne River. To be diverted in Section 12, T 4 N, R 9 E, M. D. M. for irrigation purposes on 15 acres. Estimated cost $450.00.

Application No. 5327 (Butte County)—Mayaro Lodge Company, Pulga, Butte County, Calif., for 0.50 cubic foot per second from Camp Creek, tributary to Feather River. To be diverted in Section 21, T 23 N, R 5 E, M. D. M. for irrigation and domestic purposes, 8 acres. Estimated cost $400.00.

Application No. 5331 (Butte County)—E. W., C. D., and C. C. Van Fossen, Box 133, Gridley, California, for 1.00 cubic foot per second from Lateral "E" of Rec. Dist. No. 833, tributary to Butte Creek and Sacramento River. To be diverted in Section 25, T 18 N, R 2 E, M. D. M. for irrigation purposes; 30 acres. Estimated cost $900.00.

Application No. 5332 (Merced County)—Harry Barnes for S. J. River Water Storage District, Bank of Italy Building, Los Banos, Calif., for 1000.00 cubic feet per second from reservoirs of Southern California Edison Company and San Joaquin Light & Power Corporation, tributary to San Joaquin River. To be diverted in Section 19, T 13 S, R 15 E, Section 12, T 11 S, R 13 E, Section 26, T 9 S, R 12 E, Section 17, T 9 S, R 12 E, Section 25, T 13 S, R 15 E, Section 29, T 13 S, R 16 E, Section 5, T 11 S, R 21 E. M. D. M. for irrigation purposes; 552,000 acres. Estimated cost $29,732,400.00.

Application No. 5334 (Napa County)—State Board of Control, as agents for Napa State Hospital, Veteran's Home, Napa State Farm and Game Farm, c/o Division of Water Rights, Sacramento, Calif., for 20.00 cubic feet per second and 2,000 acre feet per annum from Rector Creek tributary to Corn Creek and Napa River. To be diverted in Section 20, T 7 N, R 4 W, M. D. M. for irrigation and domestic purposes; 1,712 acres. Estimated cost $555,500.00.

Application No. 5355 (Santa Barbara County)—E. W. Alexander, County Bank, Santa Barbara, Calif., for 0.10 cubic foot per second from Arroyo Burro Creek tributary to Santa Ynez River. To be diverted in Section 12, T 5 N, R 28 W, M. D. M. for irrigation and domestic purposes; 30 acres. Estimated cost $2,500.00.

Application 5336 (Inyo County)—Herman W. Eichbaum, Darwin, Calif., for 0.001 cubic foot per second from a seep. To be diverted in Section 30, T 16 S, R 45 E, M. D. M. for irrigation and domestic purposes; 80 acres. Estimated cost $3,000.00.

Permits Issued

Among the more important permits to appropriate water issued by the Department of Public Works Division of Water Rights, California, during the month of January, 1927, were the following:

Permit No. 2696, Application No. 4854 (Humboldt County) Issued to Nanette M. Ostlund, Los Angeles, Calf., January 5, 1927, for 0.37 cubic foot per second from Bear Trap Creek in Section 2, T 5 N, R 5 E, H. B. & M. for domestic and irrigation of 30 acres in Section 1. Estimated cost $4000.

Permit No. 2697, Application No. 5222 (Sutter County) Issued to Judah Boas Finance Corporation, San Francisco, Calif., January 7, 1927, for 40 cubic feet per second from Sacramento River in Section 23, T 13 N, R 1 E, for irrigation of 1611.88 acres of rice near point of diversion. Estimated cost $9000.

Permit No. 2698, Application No. 5237 (Alameda County)—Issued to Henry Lindeman, Sr., Stockton, Calif., January 11, 1927, for 5.44 cubic feet per second from Kennedy Cut in Section 29, T 1 S, R 4 E, for irrigation of 435.8 acres near point of diversion. Estimated cost $8000.

Permit No. 2699, Application No. 5228 (Humboldt County) Issued to H. N. and N. H. Halvorsen, Bayside, Calif., January 14, 1927, for 0.12 cubic foot per second from Rocky Gulch in Section 16, T 5 N, R 1 E, H. M. for domestic and irrigation of 10 acres in Section 16.

Permit No. 2700, Application No. 5230 (Butte County) Issued to Mrs. L. A. Kister, Oroville, Calif., January 14, 1927, for 2.21 cubic feet per second from Feather River in Section 10, T 18 N, R 3 E, M. D. M. for irrigation of 177 acres near point of diversion.

Permit No. 2702, Application No. 5217 (Sonoma County) Issued to G. D. Smith, Rio Nido, Calif., January 20, 1927 for 0.56 cubic foot per second from 2 unnamed streams in Section 26, T 8 N, R 10 W, for irrigation of 45 acres in Section 26. Estimated cost $10,000.

Permit No. 2704, Application No. 4991 (San Joaquin County) Issued to Pescadero Reclamation District No. 2058, Banta, Calif., January 25, 1927, for 100 cubic feet per second from Tom Paine Slough and Paradise Cut in Sections 3, 4, 11, 12, T 2 S, R 5 E, Section 7, T 2 S, R 6 E, Section 36, T 1 S, R 7 E, for irrigation of 8350 acres near point of diversion.

Permit No. 2708, Application No. 5202 (Ventura County) Issued to Lewis C. Plush, and Wm. Plush, Stauffer, Calif., January 27, 1927, for 1 cubic foot per second from North Fork, in Section 24, T 8 N, R 22 W, for irrigation of 160 acres and domestic purposes near point of diversion. Estimated cost $4,000.

Permit No. 2710, Application No. 5265 (Butte County) Issued to Walter J. O'Neill, Chico, Calif., January 28, 1927, for 0.5 cubic foot per second from Dicus Pond in Section 24, T 23 N, R 2 W, for irrigation of 40 acres in Section 24.

Permit No. 2711, Application No. 5279 (Stanislaus County) Issued to C. C. Turner, Oakdale, Calif., January 28, 1927, for 0.69 cubic foot per second from Stanislaus River in Section 17, T 2 S, R 10 E, for irrigation of 55 acres in Section 17. Estimated cost $880.

OREGON

Among the more important applications for permit to appropriate water which have been filed in the office of Rhea Luper, State Engineer of Oregon, during January, 1927, were the following:

Richard M. Weber, Richard H. Weber and Roy C. Hill, of The Dalles, Oregon, covering the appropriation of water from surplus and overflow water of the Dalles City Reservoir and pipe line, tributary of Mill Creek, for the irrigation of 142 acres in Wasco County at an estimated cost of $1,000.00.

Town of Beaverton, covering the appropriation of water from Unnamed Springs, called No. 1, which flows into Beaverdam Creek, tributary of the Tualatin River, for municipal water supply in Washington County at an estimated cost of $12,000.

Town of Beaverton, covering the appropriation of water from Unnamed Springs called No. 2, which flows into Beaverdam Creek (Tualatin River) for municipal water supply in Washington County at an estimated cost of $12,000.00.

John F. Sapp, of Alsea, Oregon, covering the appropriation of water from Lobster Creek, tributary of the Alsea River, for irrigation of 80 acres in Benton County at an estimated cost of $500.00.

W. L. Fisher, J. R. Halland, G. C. Richardson, of Myrtle Creek, Oregon, covering the appropriation of water from South Myrtle Creek, tributary of S. Umpqua for the irrigation of 120 acres in Douglas County at an estimated cost of $2,000.00.

E. M. Wright, covering the appropriation of water from Owens Creek, tributary of Bear Creek, for irrigation and domestic use of 112 acres in Lane County, at an estimated cost of $500.00.

Oscar H. Loe, of Route 4, Silverton, Oregon, covering the appropriation of water from a Spring, tributary of an Unnamed Stream (Abiqua River) for domestic use and power and the irrigation of 10 acres in

Marion County, at an estimated cost of $700.00.

Bureau of Reclamation, Boise, Idaho, covering the appropriation of water from Malheur River, for irrigation of 33,464 acres and development of 365 theoretical horsepower, at an estimated cost of $3,000,000.

A. A. Tweedt, of Post, Oregon, covering the appropriation of water from Crooked river, tributary of the Deschutes River, for the irrigation of 69.75 acres in Crook County.

Ida M. Wilbur, of Duncan, Oregon, covering the appropriation of water from Meacham Creek, tributary of the Umatilla River, for the irrigation of 40 acres in Umatilla County.

Open 145 Units in Tule Lake Division of Klamath Project

Public notice has been issued by the Secretary of the Interior announcing the opening to entry on March 1, 1927, of 145 public land farm units in the Tule Lake Division of the Klamath irrigation project, Oregon-California, it was announced by the Department of the Interior in January.

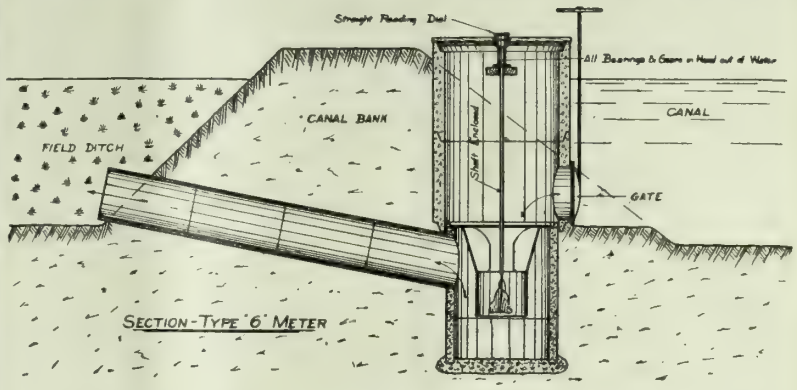
The division will be operated on a water-rental basis until its agricultural development has advanced sufficiently to permit a district organization, at which time a so-called joint liability contract will be required, as provided for in Section 45 of the act of May 25, 1926, and the construction charge will be announced at $88.35 per acre payable over a 40-year period. Should the water users fail or refuse to organize a district and enter into the contract, it will be necessary to issue public notice under the Extension Act of August 13, 1914, without regard to the write-off under the recent Adjustment Act and under a 20-year repayment plan. This would result in a construction charge of $100.55 per acre payable in 20 years.

Under the present public notice water will be furnished for each of the irrigation seasons of 1927 and 1928 at $1.85 an acre for each irrigable acre in the farm unit, which will entitle the entryman to 2 acre-feet of water per acre. Additional water will be furnished at the rate of 75 cents per acre-foot. The irrigable area of the farm units averages about 50 acres.

Hermiston Canal Completed

Construction work on the canal system of the Hermiston, Oregon, irrigation district, started about the middle of September, 1926, has been finished. Under the contract of May 31, 1921, the government agreed to spend $780,000 on the system of the district. Up to the present $660,000 has been spent, according to recent reports from the district, leaving the sum of $120,000 still to be expended.

The RELIANCE METER



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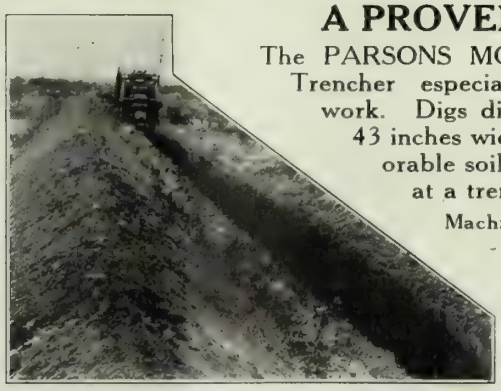

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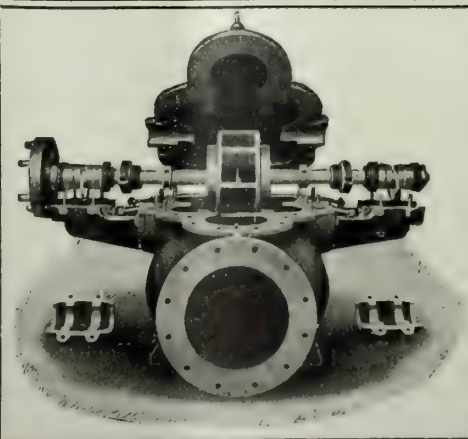

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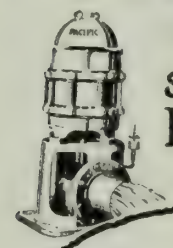

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CATALOG AND ADVISORY SERVICE ON REQUEST

Cotton Grown on U. S. Projects in 1926 Worth $13,764,585

Statistics compiled by the Bureau of Reclamation, show that last year cotton was grown on nearly 210,000 acres on 5 Federal irrigation projects in the states of California, Arizona, New Mexico, and Texas, producing 166,000 bales of 500 pounds each, and 160,000,000 pounds of seed valued as a whole at $13,764,585, or $65.59 an acre.

The largest area devoted to the crop, amounting to 83,337 acres, was on the Rio Grande project, New Mexico-Texas. The largest production, amounting to 31,317,200 pounds of lint and 62,634,400 pounds of seed, came from the Salt River project in Arizona, which also had the highest total value of the crop, amounting to nearly $6,000,000, and the highest value per acre, amounting to $74.46. These yields and total value were followed closely by the Rio Grande project, New Mexico-Texas, although the per acre value of the crop was nearly $12 less. Long staple cotton was grown in the Salt River project on 18,686 acres. Complete statistics are given in the accompanying table.

COTTON GROWN ON FEDERAL IRRIGATION PROJECTS, 1926

Project	Acreage	Unit of Yield	Yields				Value	
			Total		Average per Acre		Total	Per Acre
			Lint	Seed	Lint	Seed		
Salt River	79,465	lb	31,317,200	62,634,400	394	788	$5,916,841	74.46
Yuma	29,155	lb	12,545,672	25,091,344	430	860	1,656,032	56.80
Orland	279	lb	36,000	72,000	129	258	15,187	54.43
Carlsbad	17,615	lb	6,378,840	17,234,000	362	978	967,113	54.90
Rio Grande	83,337	lb	32,680,800	55,376,000	392	664	5,209,412	62.51
Total	209,851	lb	82,958,512	160,407,744	395	764	$13,764,585	65.59

Launch Water Saving Plan

Longmont, Colorado, was the scene of a recent meeting of a committee appointed by the Boulder County commissioners to confer on water conservation problems. The committee advocated the formation of a water district including all the territory between the continental divide east to the state line, and from the divide country north to the Wyoming line. The district is to be established on a cooperative rather than a competitive basis that equal benefits may be derived by the entire district. The committee passed a resolution in favor of a law authorizing the state engineer to fill reservoirs in order of their altitude. Two representatives from the state legislature were present at the meeting.

In order to make Bakersfield, California, safe from Kern River floods during the coming spring freshet season, the river bed has been cleared of debris and brush for a distance of three miles, six hundred feet of the channel has been deepened with a dredger to force the current to follow a straight line, and the north levee has been strengthened. The work cost approximately $3,000.

Citrus Crops on U. S. Projects

Advance statistics prepared by the Bureau of Reclamation show that last year citrus fruits were grown on 2,603 acres on three irrigation projects of the bureau. Nearly 23,000,000 pounds of fruit were produced, valued at $1,035,000, or nearly $400 an acre.

Of the total production nearly 21,000,000 pounds were grown on the Salt River project in Arizona, and the crop was valued at $944,000, or $540 per acre. Complete statistics concerning the crop are given in the accompanying table:

CITRUS FRUIT GROWN ON IRRIGATION PROJECTS, 1926
(Advance Figures)

Project	Acreage	Total Lbs.	Per Acre Value
Salt River	1,749	20,988,000	$540.00
Yuma	2	1,800	150.00
Yuma Auxiliary (Mesa)	558	750,600	50.68
Orland	294	1,165,275	210.00
Totals and averages	2,603	22,905,675	397.70

Eaton Canyon Bids Due Soon

With work now under way on a new road through the Angeles national forest to connect the Mt. Wilson toll road with the site of the Eaton Canyon dam, a distance of four miles, it is probable bids on the dam will be asked for by the county supervisors early in April, according to a recent announcement by Roy W. Dowds, flood control counsel.

The forestry department has granted permission to construct the new road over the government reserve. Access to the dam site from Pasadena will be by way of the Mt. Wilson toll road and the new road, a total distance of eight miles.

A bond issue for $603,000 was voted to pay the cost of the dam.

Grants Pass Has Good Year

The Grants Pass, Oregon, irrigation district reports a prosperous year during 1926 and a favorable outlook for 1927. The district consists of 16,000 acres of fertile land of the Rogue River Valley. Gravity canals and pumping mills carry the water diverted from Rogue River by the Savage Rapids Dam, giving an unfailing supply during the summer months. The farms average from five to twenty acres each. It is reported that a record of one new settler a day in the district has been maintained during the past year.

For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

MEMBERS OF PUMP CONCERN IN CONVENTION FOR DISCUSSION OF MUTUAL PROBLEMS.

Hold Pump Convention

The Pacific Pump Works believes in close co-operation between the various members of their large organization, and the company officials. It is easy to work with people who know and understand each other, and who are imbued with the same spirit. One of the members of this organization defined co-operation in the following manner, "So conduct yourself that the other fellow can work with you."

"Co-operation" was the compelling motive that caused the company to hold a convention of all the salesmen and dealers of Pacific Pump equipment. This was held at the Los Angeles factory, January 5, 6 and 7, and took the form of an informal get-together rather than a cut and dried convention. The various members of the staff were given a concentrated course of study upon Pacific deep well pumps, and Pacific horizontal centrifugal pumps. Many of the dealers and salesmen presented their individual problems of water development, which prevailed in their particular territory, and these problems were discussed by all members in attendance.

The social feature was a barbecue served on the Bastanchury ranch near Fullerton, on the last day of the meeting. A convention will hereafter be held each year.

Sewer Permit Is Granted

(*Continued from Page 43*)

Angeles Chamber of Commerce report, concurred in by the writer.

The treatment by plain sedimentation will remove five times more solid matter than fine screens will; will remove fifty to seventy-five times more of the bacteria, compared to practically nothing by fine screening; and will be susceptible to further treatment by chlorination at a not excessive cost if such becomes necessary.

It is therefore incumbent on the districts to secure a new permit from the State Board of Health and obtain rights of way from the City of Los Angeles for a final line. The conditions of permit specified for the breakwater line will probably be the same for White's Point. It therefore appears that, although there has been a temporary setback, the districts are much nearer to securing their long-desired outfall than at any time in the past.

New Company Formed

The Morris Engineering Corporation, recently organized in Los Angeles, reports that one of its principal objectives is the building of streets and highways by using the Hunt process for the curing of concrete. Readers of MODERN IRRIGATION will remember that a description of this process was given in the November, 1926, issue by F. W. McRae, chief engineer of the Everlasting Paint and Sales Company. The officers of the Morris Corporation are: W. H. Antram, a member of the Los Angeles Building and Safety Commission, president; C. T. Wardlaw, president of the Van Nuys Finance Corporation, vice president; and Edward R. Young, attorney, secretary and treasurer.

Sinclair Joins Hill Hubbell

A. P. Sinclair, lately connected with the Missouri Paint & Varnish Company, is now associated with Hill, Hubbell & Company, whose main office is in San Francisco. A recent announcement from the company states that they have obtained from Mr. Sinclair the right to manufacture and sell the original L & S Portland Cement Paint, which has more recently been manufactured under other trade names. Mr. Sinclair will devote his time to the distribution of this paint, stocks of which are available at the various branches of the company and through their authorized distributors.

Engineers Visit Dams

On Saturday, January 29, one hundred and twenty members of the Los Angeles section of the American Society of Civil Engineers were the guests of the Los Angeles city water department and the county committee on flood control on a trip to the Pacoima dam, the upper and lower San Fernando dams, and the Chatsworth dam.

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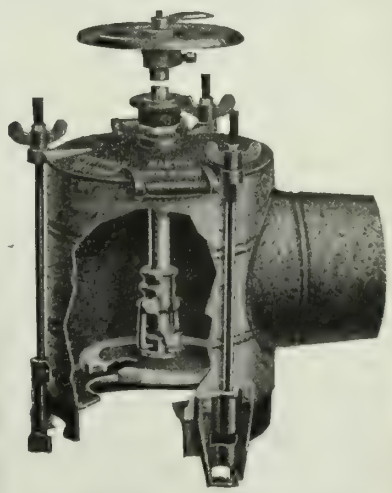

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AMONG OUR CONTRIBUTORS

Editorial Jottings About Current and Forthcoming Feature Articles, Dealing With Practical Problems of Hydraulics, and the Men Who Have Written Them

WILLIAM DURBROW, who writes on the problems of financing an irrigation district, is an authority on irrigation matters. He has been since 1923 the president of the Irrigation Districts Association of California, and is also trustee and president of Reclamation District 2047, a district containing a quarter of a million acres, organized for draining the west side lands of the Sacramento Valley.

Mr. Durbrow was graduated from the University of California in 1899. After spending a few years in mining and smelting work, including an extensive trip to the west coast of South America, he became, in 1903, engineer and manager of water and power properties in Butte County, California, which later became known as the Oro Electric Corporation. It was about this time that Mr. Durbrow became interested as a land owner on the west side of the Sacramento Valley.

During the World War he served as Food Administrator of Glenn County, California. In 1919 he was one of the leading organizers of the Glenn-Colusa Irrigation District, one of the largest in the state. He was made president of the district and held this office until he resigned it to become secretary and manager of the same district. In 1924 he was appointed a member of the permanent committee of the Sacramento-San Joaquin River Problems Conference, and has taken a prominent part in the working out of the difficulties along the Sacramento. MODERN IRRIGATION feels that it is to be congratulated on having Mr. Durbrow as a member of its advisory board and as a contributor.

FRED FORBES HENSHAW, who contributes the article on Stream Utilization, is district engineer in charge of the Oregon district for the Water Resources Branch of the United States Geological Survey, a position he has held since 1910. Mr. Henshaw is a graduate of the Massachusetts Agricultural College. In 1905, the year following his graduation, he joined the forces of the U. S. G. S. and served successively as hydraulic aid, assistant engineer, hydraulic engineer, and in his present position as district engineer. He is the author of numerous papers and reports on sources of water supply.

PAUL BAILEY, State Engineer of California, needs no introduction to the readers of MODERN IRRIGATION. His report to the legislature on the water resources of California, and the program he has mapped out for the development and conservation of these resources, excerpts from which are given in this issue, have been awaited with great interest. This report summarizes the results of thorough investigation and research. Like any other program of similar magnitude, it will doubtless find warm adherents and bitter opponents, but it is to be hoped that the public generally will give it thoughtful study.

RAY F. GOUDEY is well known to many of the readers of MODERN IRRIGATION, who will recall his article in the June, 1926, issue on the chlorination of irrigation supplies and their use in domestic systems. Mr. Goudey was one of the seven men who founded the California section of the A. W. W. A. He was graduated from the Massachusetts Institute of Technology in 1917, and a few months later became assistant engineer with the California State Board of Health, with headquarters at Berkeley. In 1921 he was sent to Los Angeles as resident engineer of the southern division of the board.

During the ten years Mr. Goudey has been connected with the Board of Health he has made a special study of epidemics and has been one of the leaders in the United States in tracing their causes. He reports that in more than a thousand instances he has found the epidemic due directly to the water in use. Since Mr. Goudey has been stationed in Los Angeles he has reviewed the water supply sources and sanitary disposal methods of virtually every city south of the Tehachepi.

EARLE B. PHELPS is a consulting sanitary engineer in New York City, who has contributed to scientific and engineering journals many articles on various phases of sanitation. Mr. Phelps was graduated in 1889 from the Massachusetts Institute of Technology and for the next four years was connected with the Lawrence Experiment Station, maintained by the Massachusetts State Board of Health. From 1903 to 1913 he was a member of the teaching staff of his alma mater, in the Sanitary Research Laboratory and Sewage Experiment Station, and as assistant and then associate professor of chemical biology. In 1913 he became a member of the U. S. Public Health Service as senior sanitary engineer, and professor of chemistry in the hygienic laboratory. This position he held until he opened an office of his own as consulting engineer in 1919. Mr. Phelps has made original investigations in sewage disposal and has been one of the leaders in the development of chemical disinfection of sewage. He has conducted many investigations of water supplies and allied problems for the War and Navy departments.

ORMOND A. STONE, who writes of the sewage disposal plant at Banning, is a partner in the municipal and civil engineering firm of Olmsted & Gillelen, Los Angeles. Mr. Stone was graduated from the University of Virginia in 1913. For the two years immediately following he was connected with the Putnam Stone Construction Company, bridge contractors. Since 1915 he has been located in Los Angeles, where he has been in charge of the design and construction of many municipal and irrigation projects.

ROBERT SCHURMAN brings to his account of the "Standard Form of Purchase Agreement for Deep Well Pumping Equipment" a wide experience in the manufacture and sale of pumps as vice president, sales manager and treasurer of the Byron Jackson Pump Manufacturing Company. Mr. Schurman is also past president of the Pacific Hydraulic Engineering Association. He was graduated from Cornell University under the presidency of his father, Jacob Gould Schurman, now ambassador to Germany, and during the Harding administration minister to China.

MODERN Irrigation

The Magazine of Applied Hydraulics

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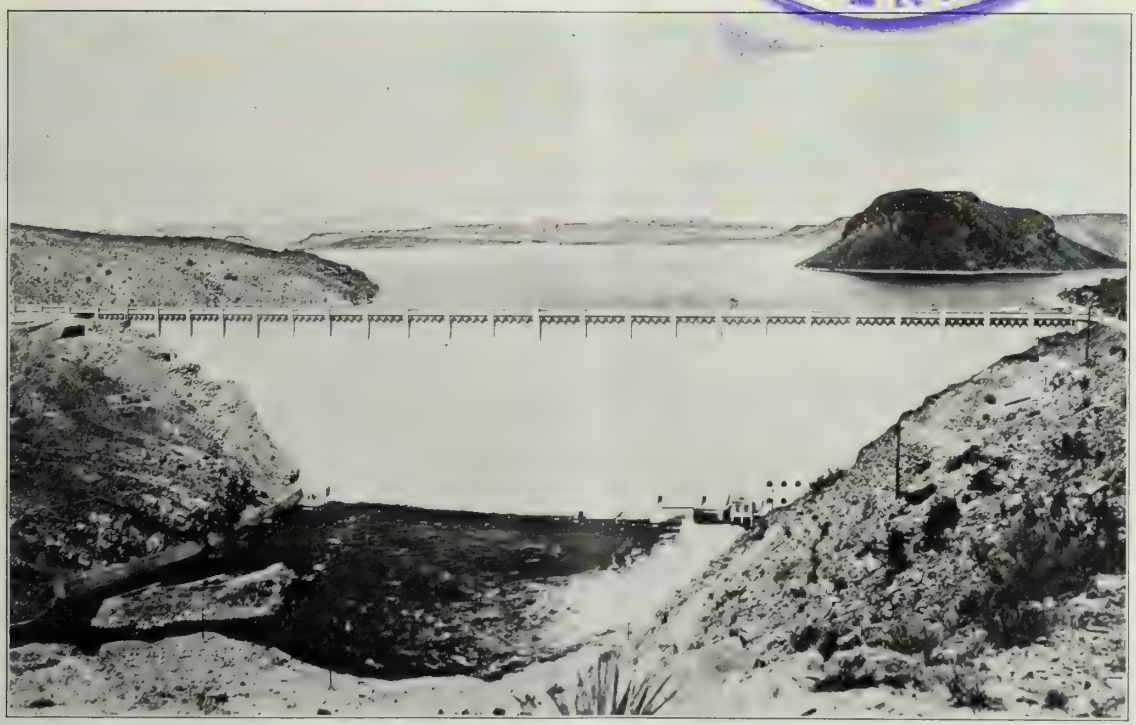

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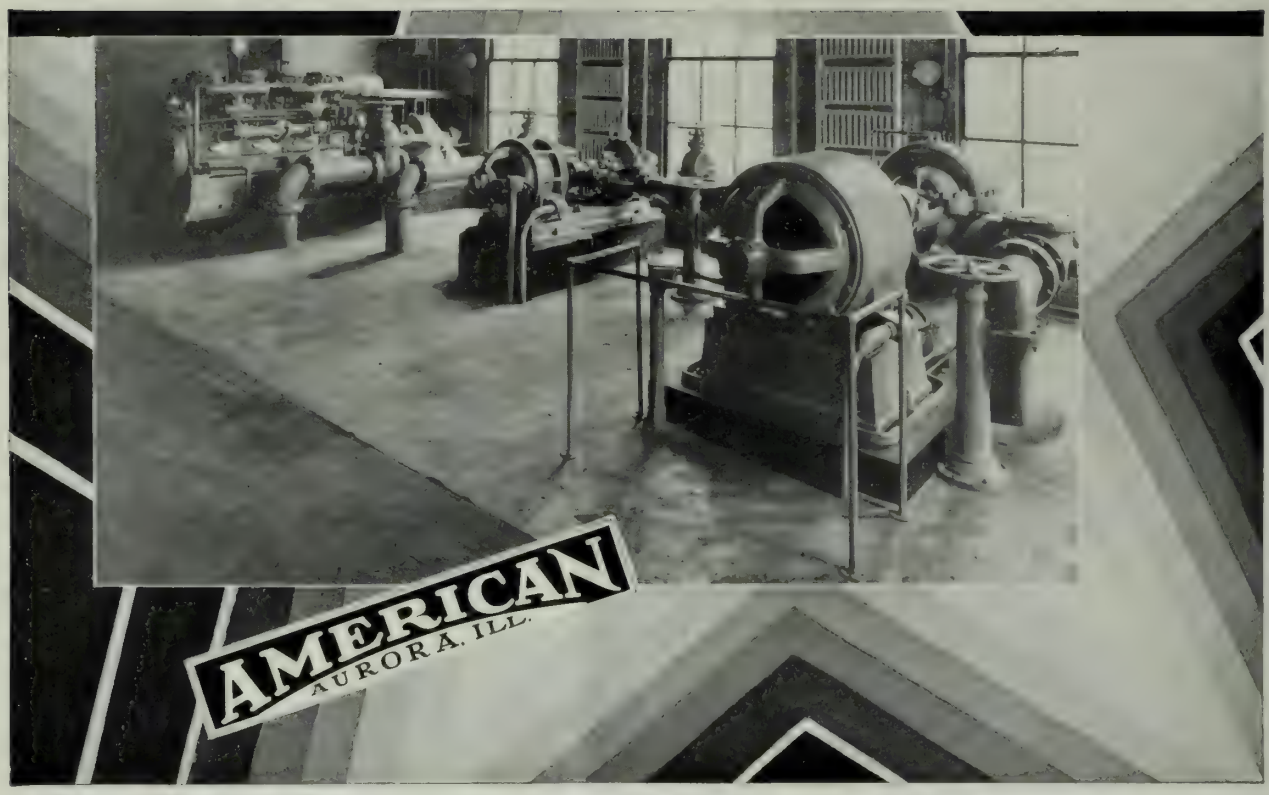

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All these motors are provided with Sundh automatic starters. This installation was made in 1924 and replaced the old steam-driven station that had been in service for a considerable length of time. City engineers should be interested in the economies effected. "American" engineers will be glad to furnish details.

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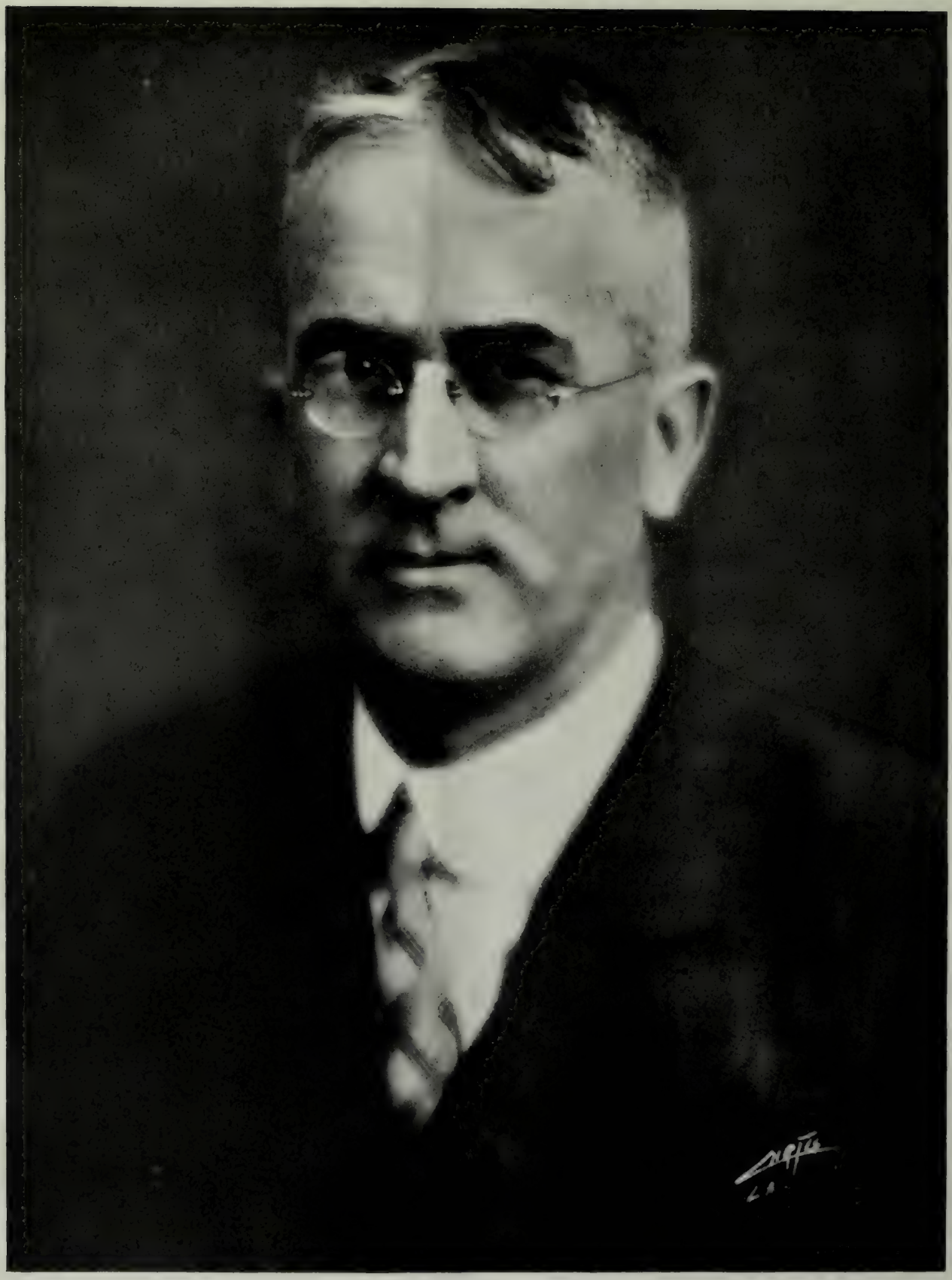
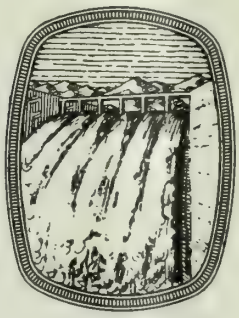


FREDERICK H. FOWLER

Consulting Engineer of San Francisco, who has been retained by the Los Angeles Chamber of Commerce as one of the three consulting engineers comprising the advisory board which will make a report on the San Gabriel River dam. Mr. Fowler was for many years assistant chief engineer of the U. S. Forestry Service, and has made innumerable investigations on various water problems of the west. Many of these reports are comprised in the reports of the United States Geological Survey.

MODERN Irrigation

The Magazine of Applied Hydraulics



Volume III MARCH, 1927 Number 3

The Progress *of* Irrigation

IN 1926, crops valued at more than $60,000,000 were grown on Federal irrigation projects in the United States. According to advance figures prepared by the Bureau of Reclamation, 1,409,932 acres were irrigated on 24 irrigation projects. Of this area, we are told, 1,311,405 acres were cropped, producing crops having a gross value of $60,331,245 or $46 per acre.

In contrast to this figure of $46 per acre on the Federal irrigation projects it is interesting to note that the average value per acre in 1926 of 10 principal crops, comprising nearly 90 per cent of the area in all field crops for the United States as a whole, is estimated by the Department of Agriculture at $19.07.

As Dr. Elwood Mead, Commissioner, Bureau of Reclamation, recently pointed out, the very nature of irrigation practice leads to closer settlement and cooperation on the part of the settlers. Each project is dependent on a common water supply, their needs are served through a common main canal, and their mutual interests are necessarily interlinked more closely than in agricultural communities in the humid regions.

In 1925, Dr. Mead states, the population of the 37,530 irrigated farms on the projects numbered 136,872, and that of the 203 project cities and towns an additional 365,742. The educational needs of the settlers are well served by 656 schools, including consolidated schools and high schools, and their religious requirements by 645 churches of all denominations. The 146 project banks reported deposits amounting to $125,222,000.

Secretary Work puts the situation in these words: "The Bureau of Reclamation has been placed on a sound basis of business efficiency and has been re-established as a home-making branch of the government for which it was originally created."

While lack of space prevents any state-by-state summary of reclamation in any one issue of this magazine, the progress of Arizona stands out, just at present, as a notable example of what intelligently directed reclamation plans are accomplishing in a practical way. Great things have been done in the state during the last year, with much remaining in formative stages. Estimate has been made that the state now has 510,000 irrigated acres, that a gain of 40,000 acres has been made in the past year and that a

"Western Waterworks" Begins on Page 25

jump of 700,000 acres may be expected within the next two years.

Tributary to Phoenix, within the Salt River Valley, 324,000 acres are under cultivation, this development having been chronicled at some length in the last issue of MODERN IRRIGATION. East of Mesa are being added 40,000 acres in the Roosevelt Water Conservation District with new pumping areas being developed still farther to the eastward. North of Phoenix lies the Verde River project, with 80,000 now arid acres about to be added to the local project after settlement of differences with the local association.

To the northwest lie the 42,000 acres of the Beardsley - Agua Fria project, which has floated a bond issue of $3,325,000 and which is completing a storage dam on the Agua Fria River. Paralleling this, we are told, are about 40,000 acres to be irrigated by a company that is building a storage dam on the Hassayampa River, far up in the mountains. West of Phoenix and west of the Agua Fria River lie about 30,000 additional acres, under the Roosevelt irrigation district which will take surplus pumped water from the Salt River project.

THE FLEXIBILITY OF DEEP WELL TURBINE UNITS MAKES THEM READILY ADAPTABLE TO MANY PHASES OF CONSTRUCTION, AND THEY ARE FOUND TO BE PARTICULARLY VALUABLE DURING THE CONSTRUCTION OF DAMS. THE PICTURE SHOWS AN APPLICATION OF BYRON-JACKSON UNITS WHICH HAVE BEEN LOWERED INTO A DE-WATERING PIT. THIS INSTALLATION IS ON THE BEARDSLEY DAM, WHICH IS NOW UNDER CONSTRUCTION NEAR PHOENIX.

Along the Gila River, nearly all the way to Yuma, work is being done on projects that may mean the reclamation of even 200,000 acres, through storage and pumping of water. In the Gila Valley, also, between Florence and Casa Grande, and on the Pima Indian Reservation, long deferred construction on the San Carlos project will add at least 100,000 acres to the wealth of the state, with incidental expenditure of $5,500,000 on the Coolidge storage dam and collateral works. A large acreage of new land has been put under cultivation at Yuma.

California water development, too, has been much in the public prints since Paul Baily, state engineer, made his report to the state legislature of a plan whereby, through coordination of effort, those sections deficient in water supply may enjoy adequate water for agricultural and all other purposes. Recommendations for development in the Sacramento and San Joaquin Valleys alone call for expenditures aggregating $334,000,000. Working out of the Bailey plan is thought to be vitally affected by the recent decision of the California Supreme Court in the well-known Herminghaus case. This decision upholds the riparian owner's right to be the sole judge of what is reasonable in the use of water flowing past his land, and says in effect that so long as any river bank proprietor can claim that some advantage accrues to him from flooding, the flooding must continue and must not be prevented by upstream storage.

Now, however, an amendment to the state constitution, which would radically change water laws of the state, has been introduced in the Assembly. The amendment would provide that the water resources of the state be put to beneficial use and that the conservation of such water be within the police power of the state and subject to the state's control with a view to its reasonable and beneficial use. The introduction of the measure is, of course, the result of a study during the last few weeks by a special Senate and Assembly committee of the effects of the Herminghaus decision on the Bailey plan.

Legislative matters affecting irrigation and reclamation are alike the center of interest in Oregon where bills, including recommendations of the Ochoco committee and propositions approved by the Oregon Reclamation Congress, have passed both houses of the Legislature and should aid in the rehabilitation of distressed reclamation projects. These bills are H. B. 115 and 114, introduced by Representative Hazlitt. Numerous

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Geologist Says Earthquake Hazard Hurts Granite Dike Site for San Gabriel Dam

Declares Structure at This Point Would Be Perpetual Interrogation Point of Builder's Prudence and Wisdom

By ANDREW C. LAWSON

Professor of Geology, University of California

A Report to the San Gabriel Valley (California) Protective Association

IN ACCORDANCE with the request of your president I have made a geological examination of the Granite Dike dam site on the San Gabriel River for the purpose of comparing it with the Forks dam site a few miles farther up stream, and beg to advise you as follows:

The general geological features of the two sites are much the same. The prevailing formation is a dark, rather basic granite rock, which is shot through in all directions by irregular dikes of a light-colored, acid granitic rock. There are also a few small dikes of common volcanic rock of still later date encountered here and there on the sides of the canyon. The whole mass of San Gabriel Mountain has been relatively uplifted, and in the process has been greatly broken. Slips and faults traverse the rocks in all directions, and upon these adjustments of stress have been effected which have tended to stabilize the mass as a whole. The process of stabilization is probably complete and there is now little danger of further movements on any of the many small slips which traverse the mass.

The San Gabriel Mountain mass is, however, bounded by two master faults, the one on the north being the San Andreas fault, and that on the south the one which determines the course of the mountain front. Movements on either of these might give rise to a redistribution of stresses which would necessitate further adjustments within the mountain mass. Such adjustments would not in my opinion occasion large displacements.

Faults Related

While this is so, it appears that whatever risk of movement there may be in the region traversed by the San Gabriel River that risk is greater at the Granite Dike site than at the Forks site. The Granite Dike site is located on a zone of rather pronounced faults which have a prevailing strike of north-northeast and a dip to the west. These have each of them a pronounced fault breccia, gouge and fluted walls, indicative of a larger movement than that which characterizes the more prevalent or ordinary adjustment slip.

These faults are in all probability intimately related to the great east--west fault which bounds the range, a mile and a half or less to the south. The largest of these cross faults traverses the proposed dam at the Granite Dike site and if movement were to occur on it, it would undoubtedly break the dam. It may be referred to as the Granite Island fault, since it is best exposed in a cove on the north side of Granite Island. Here between two well-defined slickensided and fluted walls is a body of fault breccia not less than eighteen feet wide. To produce such a breccia the amount of movement must have been large. To the south of Granite Island the Granite Island fault is represented by three faults with well-defined walls and breccias of from one to four feet in width. These are exposed on the roadside just to the west of the north portal of the new railway tunnel.

To the north of the dam site, the Granite Island fault, or at least a fault in the same line having the same general strike and dip and the same magnitude of fault breccia, is exposed again at the bend of the river at a point 1300 feet north-northeast of the north side of the proposed dam. Still further upstream in the same line is another exposure of a fault which is probably the same, although here the fault breccia is much less developed. The evidence is clear as to general position and course of the fault and it is certain that it lies close to the east bank of the river in the foundation of the proposed dam.

ANDREW COWPER LAWSON, professor of geology of the University of California, who presents the geological report on the two sites proposed for the San Gabriel Dam, is a native of Scotland and is a graduate of the universities of Toronto and Johns Hopkins.

From 1882 until he became connected with the University of California in 1890, Professor Lawson was a member of the Geological Survey of Canada. He is considered one of the foremost authorities on the geological aspect of earthquakes, and was appointed chairman of the California Earthquake Investigation Commission in 1906, just after the San Francisco disaster. He was a delegate to the Geological Congress of London in 1888, to that of St. Petersburg in 1897, and to that of Toronto in 1913. He is a Fellow of the Geological Society of America, and past president of the Seismological Society of America. In 1923 he was chairman of the division of geology and geography of the National Research Council. He is the author of numerous geological papers and monographs, and is editor of the Bulletin of the Department of Geology, published by the University of California.

Element of Danger

Now it is probable that this is a dead fault, and that the stresses which caused movement upon it have long since been adjusted. But probability is not certainty and, in the event of renewal of movement on the great fault on the southern margin of the range, there might be a sympathetic slip on the Granite Island cross-fault. There is at least sufficient risk to cause the responsible engineers serious concern. Every constructing engineer will agree with me that in the erection of structures whose failure would mean great disaster and enormous loss of life, risk should be reduced to the uttermost minimum. Even if I am right in my opinion that the Granite Island fault is a dead fault its existence, clearly exposed on the two sides of a high dam, would be a perpetual interrogation mark as to the prudence and wisdom of the engineer that built it. People living in the valley lands below the dam will always know of the existence of the fault. There will be plenty of alarmists who will not fail to tell them, and during the life of the dam these people will be troubled by the apprehension of the possibility of a break which will be suggested by the mere existence of so real a fault as that exposed at Granite Island. If I lived in the valley below the dam I should not be myself entirely free from apprehension, even thought I should be fully aware that it was highly improbable that any movement should take place on the Granite Island fault. I should know all the time that probability was not the certainty of safety that good en-

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LEASBURG DIVERSION DAM, RIO GRANDE FEDERAL IRRIGATION PROJECT, NEW MEXICO-TEXAS, ON THE RIO GRANDE, 60 MILES ABOVE EL PASO.

Intelligent Investment and Organized Effort Pays on the Rio Grande

By L. M. LAWSON*

THE Rio Grande is second only in importance to the Colorado River as an irrigation source of the Southwest. In its entire course of 1800 miles between its source in Colorado, and the Gulf of Mexico, the Rio Grande Federal Irrigation project is the principal development where complete storage, distribution and drainage is provided.

The storage dam at Elephant Butte, 135 miles above El Paso, Texas, creates the largest artificial lake in the United States for irrigation and furnishes a dependable water supply from the otherwise erratic Rio Grande to lands in New Mexico, Texas, and the Republic of old Mexico. The area possible to irrigate is now fixed at approximately 200,000 acres of which 185,000 are at present in cultivation.

The average size of the land tracts is 30 acres although the plans of the Bureau of Reclamation call for the delivery of water to each 160 acres. The long ribbon-like valleys of the Rio Grande below Elephant Butte Dam are rapidly being placed in cultivation and the project as a whole provides a demonstration of cooperative improvement and community building on the part of the United States and the land owners, which is an example of what can be attained in carrying out the purpose of the Reclamation Act which had as its most important feature, the creation of homes and opportunities for American citizens. Located as it is, as one of the gateways to Mexico, surrounded by desert country for hundreds of miles, the landowners of New Mexico, Texas, and old Mexico, under the single water source and unified reclamation system, are developing a community of vast taxable wealth, of homes, and industry.

*Engineer U. S. Department Interior—Superintendent—Rio Grande Federal Irrigation Project.

Summary of Construction

Rio Grande Federal Irrigation Project

Material excavated, cubic yards, including dams, canals, drains, levees, etc.:	
Class 1	29,383,000
Class 2	218,000
Class 3	531,700
Total cu. yds.	30,132,700
Canal structures—Total No.	9,697
Bridges—Total No.	1,968
Culverts—Total No.	334
Flumes—Total No.	486
Cement used—Total Bar.	469,700
Irrigation canals and lateral—Total Miles	602
Drainage canals—Total Miles.	354

Dam Described

The Elephant Butte storage dam, located 135 miles above El Paso on the Rio Grande, is 308 feet high above the lowest foundation and the structure contains over 605,000 yards of cyclopean concrete with the up and down stream faces cast against forms. Tongue and groove expansion joints were placed each hundred feet to within one hundred feet of the parapet and each 50 feet for the remaining distance. Drainage holes 8 feet center to center are located in two

INTERNATIONAL DIVERSION DAM, EL PASO, TEXAS. IRRIGATION SUPPLY FROM ELEPHANT BUTTE DAM IS DIVERTED JOINTLY TO CANALS OF MEXICO AND UNITED STATES. RIO GRANDE FEDERAL IRRIGATION PROJECT.

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Engineering Data, Elepehant Butte Storage Dam and Reservoir

Rio Grande Federal Irrigation Project

Storage Dam

Location—On Rio Grande, 135 miles above El Paso.
Type—Rubble concrete, gravity, straight structure.
Maximum height ..... 308 Feet
Length crest ..... 1674 Feet
Volume ..... 605,200 C. Y.

Reservoir

Area ..... 40,080 Acres
Capacity ..... 2,638,000 Ac. Ft.

Drainage Area

Area in southern Colorado and New Mexico..... 30,000 Sq. Mi.
Mean annual runoff in acre feet ..... 1,158,000 Ac. Ft.

LOWER END OF ELEPHANT BUTTE RESERVOIR, RIO GRANDE FEDERAL IRRIGATION PROJECT. TOTAL CAPACITY 2,642,202 ACRE FEET, 115,098,900,000 CUBIC FEET. MAXIMUM DEPTH OF WATER, 193 FEET; SHORE LINE OF LAKE, 200 MILES; LENGTH OF RESERVOIR 45 MILES.

lines the full length of the dam. Four service gates, 4 feet by 7½ feet opening, admit water from the reservoir into a chamber from which the flow is regulated by four 5-foot diameter balanced valves.

In comparison with a large number of projects the storage capacity is unusually large, being 2,600,000 acre-feet for the 180,000 acres of land in the original project and entitled to first class water right. The large storage capacity serves two purposes—one is to store a sufficient irrigation supply over a period of low water years, which past hydrographs show can occur, and the other is to provide space for the relatively large amount of sediment carried to it and deposited by the Rio Grande. Since the completion of the storage unit in 1916, it has repaid its cost several times in the prevention of large damaging floods and in providing water for the maturing of crops on the project during several periods when the normal supply would have been insufficient. The cost of the Elephant Butte Dam was $5,000,000.00, one-fifth of which amount was contributed by the Federal Government for the delivery of 60,000 acre-feet of water annually to the Republic of Mexico.

One of the most interesting features of the storage unit of the Rio Grande Project is the data which has been possible to collect on the effect of storage on this sedimentary stream. Silt surveys were made in 1916, 1920, and 1925, and show a percentage of silt to water of 1.64 per cent and a total deposition in the reservoir of 232,000 acre-feet, or an average annual deposit of approximately 20,000 acre-feet. As might be expected in considering the effect of the heavily laden inflow on its reaching the reservoir, nearly three-fourths of the silt entering the reservoir at the present time is deposited within an area containing not quite one-fourth of the total capacity.

Project Irrigation Works

In addition to the main storage works, diversion dams have been constructed at various intervals on the river, which is used as a main canal and water is diverted into a system of main canals and laterals for delivery to farms. Over 600 miles of main canal and laterals have been constructed and are in operation delivering irrigation water to about 5000 separate tracts of land in the original portion of the project in New Mexico and Texas.

The project is naturally divided by valleys into four divisions with a diversion dam at the head of each division and a system of distributaries. Percha Diversion Dam is located 20 miles below Elephant Butte and at the head of the Rincon division of the project. Leasburg Diversion Dam, 60 miles above El Paso is the principal feature of the Leasburg Division. The Mesilla Diversion Dam, about 40 miles north of El Paso, diverts water for the East and West Side Main canal systems of the Mesilla Valley. The International Diversion Dam at El Paso provides diversion for canal systems in both the United States and the Republic of Mexico and is at the head of the lower division and portion of the project called the El Paso Valley division. Waste and return waters of the project are collected at the lower end of the El Paso unit and rediverted for use and sale to Hudspeth County Irrigation District in Hudspeth County, Texas.

Drainage and Alkalied Conditions

With the availability of complete irrigation supply throughout the year from the storage unit in contrast to the periods of water shortage the latter half of former irrigation seasons, the necessity for the construction of drainage canals, was apparent and a system of open gravity drains, utilizing the full fall and slope of the valleys, was used. Over 350 miles of such drain have been constructed and about 300,000 acre-feet of water is annually recovered from the drains for the re-diversion and use. Large amounts of alkali which had previously collected on project lands were leached from the soil and passed out at the lower end of the project. The action of these drains has been remarkably effective and large areas of otherwise seeped and alkalied lands have been reclaimed with a small amount of effort.

GARFIELD IRRIGATION FLUME, CROSSING RIO GRANDE 100 MILES ABOVE EL PASO, TEXAS. RIO GRANDE FEDERAL IRRIGATION PROJECT

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HANLON HEADING INTAKE ON THE COLORADO RIVER IN THE IMPERIAL VALLEY. THE DIVERSION DAM ON THE RIVER AND THE WIER AT THE CANAL ENTRANCE ARE CLEARLY SHOWN. THIS MAP WAS ORIGINALLY MADE TO SCALE 1 INCH TO 1000 FEET.

Airplane and Aerial Camera Made Short Work of This Reclamation Survey

Yaqui River Staves Off Conquest for Centuries, but Finally Surrenders to Modern Science; Aerial Mapping Explained

By LEON T. ELIEL

THE YAQUI RIVER in Mexico, well-nigh impenetrable in spots and long a perplexing problem to the engineer bent on putting its waters to good use, has at last been successfully surveyed. The first step in the accomplishment of a great engineering project has been completed.

Two inventions of modern science—the aeroplane and the aerial camera—have turned the trick.

Owing to the extreme roughness of the country and the unfriendly Indians, a certain stretch of about 60 miles of the Yaqui has gone unexplored for probably a quarter of a century. During this period a large engineering project contingent upon adequate storage in this stretch of the river has been in contemplation.

The advantage of aerial mapping is no more clearly demonstrated in the history of the art than here. A trip to the upper waters of this river stretch requires more than three weeks on the ground. After arriving at the destination it is possible to explore not over one or two miles of the 60-mile canyon through which the river flows.

The airplane made the entire round trip and mapped one hundred miles of the river in three and one-half hours.

Subsequently the pictures were studied under the stereoscope and preliminary contours were developed and used to estimate dam costs and reservoir capacities.

Not An Oblique Picture

There is a sharp distinction between the oblique picture and the aerial map. The oblique picture has its greatest advantage for showing properties in a pictorial way. There is no faster way to get information. The limitations of the oblique lie in the fact that the picture has no scale and that it is individual and cannot be matched with adjoining pictures to form a map.

Aerial mapping falls under two main classifications: picture maps and line maps. All vertical pictures, whether mosaiced or not, are included in the expression "picture maps." Aerial line maps are all maps compiled from aerial maps which in their final form are drafted on tracing linen or some other suitable substance.

There are three main services available under the classification of picture maps:

1. *Contact Prints.* This service represents one print made by direct contact with each original negative. These prints are suitable for rough layouts to get the general characteristics of an area. This is accomplished by merely pinning the pictures one over another on a board. The overlapping area in contact prints is available for stereoscopic study. Practically all topography taken with the aid of aerial maps in rough country is compiled from the contact prints. Only in reasonably flat country is the mosaic suitable for this work.

2. *Rough Mosaics.* This consists of an assembly of contact prints to a rough or approximate scale. No particular effort is made to bring each part of each print to scale, and the composite map may check reasonably well by virtue of "cutting" or "fudging" the various sections into their approximate position. For many purposes such a map is sufficient as it gives the general characteristics of an area and has the continuity of a single picture. Also in case the area happens to be reasonably flat such a map may be fairly accurate.

3. *The Photographic Map.* This represents the most precise work that a successful engineering organization is able to turn out.

How Distortion Is Corrected

Not only is every picture enlarged or reduced to the best average scale and reprojected onto a tilted easel to correct for possible tilt, but several sections of an individual picture may be treated separately. In rough country it is not unusual to print a picture six or eight different times at different scales and different tilt combinations to bring each section of that picture as close to scale as possible. From the six or eight pictures so made, possibly only a small section of each is used in the final assembly. Obviously such work can only be done by the most skillful hands and requires an elaborate amount of mathematical calculations to be brought to a successful conclusion.

The aerial line map may consist of an assembly of cultural data from the pictures onto a map sheet; or it may consist of a contour map; or both. The United States Geological Survey is preparing a great many of their plane table sheets from aerial photographs before sending them into the field. On these sheets are shown all roadways, railroads, buildings and cultural data including field boundaries, etc.

When the topographer takes such a sheet into the field his task is materially reduced. He has just one thing to think of and that is contours. With the

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wealth of detail already on his sheet, together with the topographic detail afforded by the picture which he may hold in his hand, the whole task is greatly simplified.

Use of Radial Control

In compling these sheets the United States Geological Survey employs a method known as Radial Control. This method has proved very successful in certain types of work for the elimination of displacement due to differences in elevation. Furthermore, it is a highly successful way of carrying control forward from a few known points. Regardless of the scale of the picture or the differences in elevation of the ground,

THE STEREOSCOPE IS THE OFFICE INSTRUMENT BY MEANS OF WHICH ANY TWO OVERLAPPING CONTACT PRINTS MAY BE VIEWED IN RELIEF. WITH THE AID OF THIS INSTRUMENT CONTOURS ARE SKETCHED ON THE MAP.

Radial Control will carry a common scale forward to an accuracy of about 1:250, providing care is exercised in the selection of pictures. Those which are badly tilted should be discarded whenever practicable.

A surprising variety of contour maps have been successfully made by aerial methods. At one extreme is the work described on the Yaqui river which was done at a scale of 1:12500 with 30 meter contours. At the other extreme is the detailed work in the Everglade section of Florida where the airplane map was used as a basis for one foot contours.

Whether or not the aerial methods are practicable in the securing of contour information is dependent on several factors. In the first place the area must be sufficiently large to justify the probable cross-country flight necessary to get the aerial mapping equipment on the job. The area must also be of such a character that the pictures afford a sufficiency of identifiable objects for the purpose of making the map at the scale desired.

Limitations of Air Maps

In the next place the scale at which it is practical to work with present equipment is 1:18000 and larger. Aerial topography cannot compete with ground work at scales around 1:62500 and smaller.

Within these limitations it is safe to state that aerial maps may be made faster and more economically than ordinary surveys and to any degree of accuracy required. In contour work it has been found by experience that the use of aerial pictures saves all the way from nothing to 75 per cent of the usual field costs. In most instances which have come under the observation of the writer the total cost of aerial work and ground work in the production of a contour map by these methods has proved to be materially less than the cost of straight ground methods.

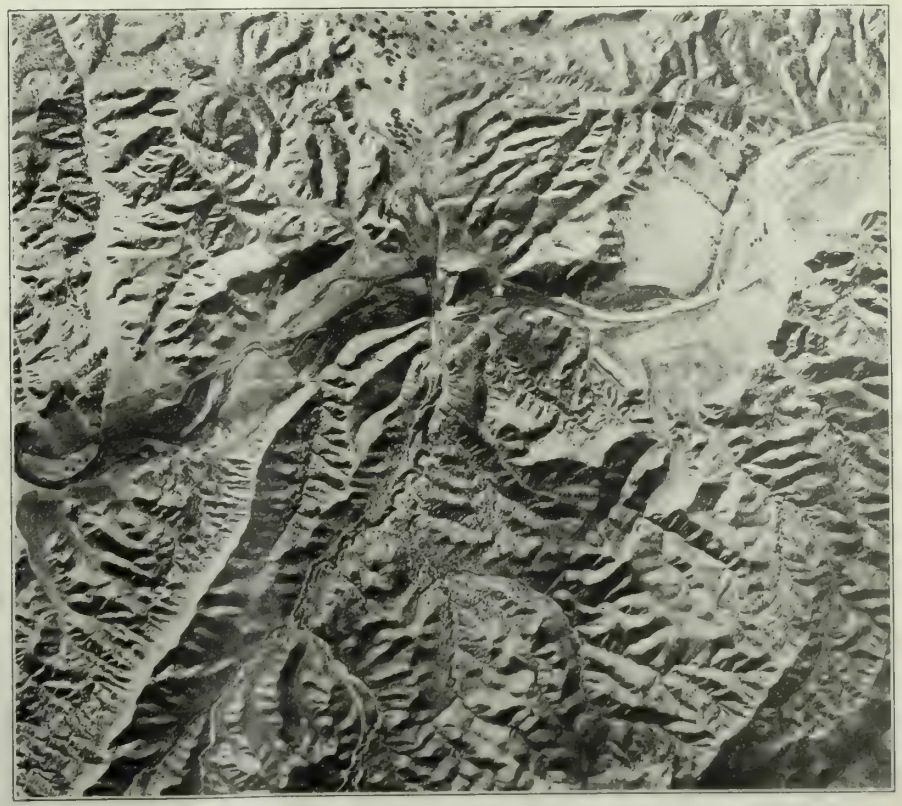
Of course there are a great many things which cannot be done by aerial mapping. It is impossible to drive stakes in the ground from an airplane. This at once limits the field of aerial mapping to the preliminary stages of a project. When it comes time to lay the project out on the ground, there still remains but one way to do it and that is to go out on the ground with men and instruments and stake it down.

Another shortcoming of aerial mapping is its inability to locate imaginary lines. Here again ground methods will always have unchallenged sway.

Future of Aerial Surveying

This discussion could scarcely be completed without some word as to the future. The art of aerial mapping develops so rapidly from year to year that the only thing more surprising than predictions which may be made for five years hence is the accomplishment of the five years past. Equipment is in process of experimentation at the present time which should make possible the mapping of 2000 or 3000 square miles on a single flight of an airplane. From the photographic information so gathered one man in from two to three months should be able to develop a contour map placing the contours within five feet of their true position with no ground control whatsoever in the entire area excepting possibly two or three known elevations. In fact, unless true elevation above sea level is required, even these points would not be necessary.

These methods should accomplish the work at such a low cost that the exploration of vast interior areas such as in South America will be practicable.



A TYPICAL AERIAL MAP. THIS IS AN AREA IN CALIFORNIA MAPPED FOR FIRM OF IRRIGATION ENGINEERS IN LOS ANGELES. THE ORIGINAL MAP WAS MADE TO SCALE 1 INCH TO 1000 FEET, BUT HAS, OF COURSE, BEEN GREATLY REDUCED FOR PURPOSE OF REPRODUCTION.

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Canada Studies the Irrigation of Sugar Beets

Province of Alberta Conducts Exhaustive Tests to Determine Best Procedure for Culture

By H. W. SNELSON

Senior Irrigation Specialist—Dominion of Canada

SUGAR BEET production is a comparatively new industry in the province of Alberta and most farmers engaged in growing this crop are not so well advised as they should be regarding the seasonable water requirements of this plant and the correct methods of supplying this requirement by irrigation to the crop when grown on soils of different texture and fertility.

During the growing season of 1926, the Dominion Irrigation Experiment Station at Brooks, Alberta, had seven different crop-series upon which irrigation investigations were conducted to determine the influence of moisture and soil fertility upon the production of sugar beets. The moisture available to the growing crop carried from one 4-inch irrigation to five 4-inch irrigations, plus the rainfall between seeding and harvest. The soil fertility ranged from excellent after legumes to only fair after non-legume crops.

Each plot was approximately 1-30 acre in area. Water was applied by irrigation, measured through 90° "V" notch weirs, and retained on the plots by earth borders. On series 48, the soil moisture content, to a depth of six feet, was determined every 4 to 6 days. On the six other crop-series the soil moisture content was determined at the time of seeding and harvest only.

Preceding Crops

The following table shows the crops grown on each series for six years prior to 1926:

Series	1920	1921	1922	1923	1924	1925	1926	Max. yld. '26 per acre
48	Flax.	Alfalfa	Alfalfa	Alfalfa	Alfalfa	Alfalfa	Beets	16.8 t
46	Alfalfa	Alfalfa	Alfalfa	Alfalfa	Alfalfa	Potatoes	Beets	20.1 t
44	Alfalfa	Alfalfa	Alfalfa	Alfalfa	Potatoes	Wheat	Beets	18.0 t
42	Alfalfa	Alfalfa	Alfalfa	Potatoes	Wheat	Flax	Beets	16.1 t
68	Oats	Wheat	Oats	R. Clover	R. Clover	R. Clover	Beets	17.9 t
66	Wheat	Oats	R. Clover	R. Clover	R. Clover	Corn	Beets	19.6 t
83	Potatoes	Barley	Wheat	Grass	Grass	Grass	Beets	10.9 t

In order to determine the most economic irrigation that should be applied to the designated plots, accurate records were kept of each application, and the procedure followed in each respective case. The rainfall was also recorded, and this taken into consideration in the compilation of the total amount of water received by the plot. Herewith is the record of the irrigation:

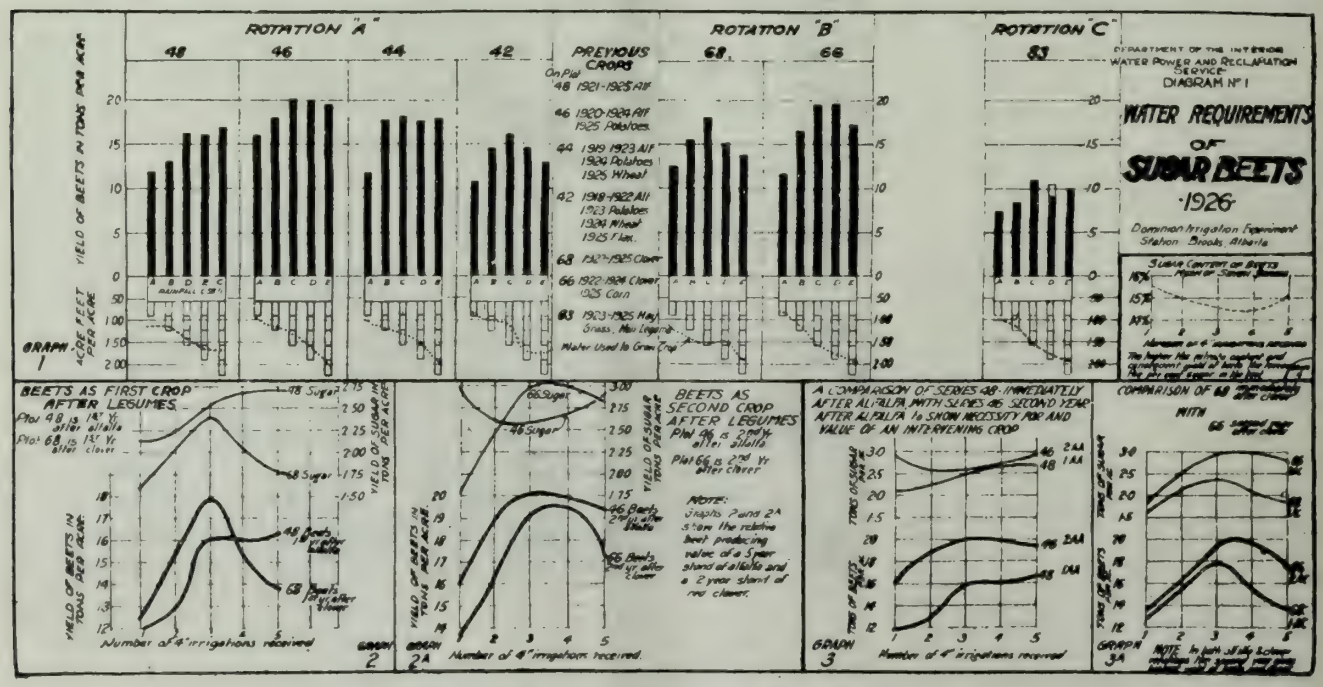
The irrigation investigations as carried out provide authentic data on the water requirements of the sugar beet crop when grown under soil and climatic conditions comparable to those obtaining in this district.

Results of Experiments

Rotation A—For series 46, 44, and 42, the maximum yield in each series was produced where *three 4-inch irrigations* (1.00 ft.) were received by the crops in addition to the rain, (.58 foot). Where either more or less than 3 irrigations were applied the yield was less than the maximum. For series 48 the maximum yield was obtained with 5 irrigations (48c) but the increase in yield over that obtained with 3 irrigations

WATER RECEIVED AND USED FOR MAXIMUM YIELDS OF BEETS 1926

Series	Plot	Irrigation	Rainfall Inches	Total water Rec'd.	Water Used	Yield per acre
48	D	3x4"=12"	7"	19"	17.2	16.1 tons
46	C	3x4"=12"	7"	19"	15.4	20.1 tons
44	C	3x4"=12"	7"	19"	16.1	18.0 tons
42	C	3x4"=12"	7"	19"	12.6	16.1 tons
68	C	3x4"=12"	7"	19"	18.7	17.9 tons
66	C	3x4"=12"	7"	19"	19.2	19.6 tons
83	C	3x4"=12"	7"	19"	19.2	10.9 tons


ROTATION "A"
ROTATION "B"
ROTATION "C"
PREVIOUS CROPS
DEPARTMENT OF THE INTERIOR WATER POWER AND RECLAMATION SERVICE
DIAGRAM Nº 1
WATER REQUIREMENTS OF SUGAR BEETS 1926
Dominion Irrigation Experiment Station Brooks, Alberta
BEETS AS FIRST CROP AFTER LEGUMES
BEETS AS SECOND CROP AFTER LEGUMES
A COMPARISON OF SERIES 48 IMMEDIATELY AFTER ALFALFA WITH SERIES 46 SECOND YEAR AFTER ALFALFA TO SHOW NECESSITY FOR AND VALUE OF AN INTERVENING CROP
Number of 4" irrigations received
GRAPH 1
GRAPH 2
GRAPH 2A
GRAPH 3
GRAPH 3A

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(48d) is but .7 ton at a cost of two 4-inch irrigations, therefore three irrigations may be considered to have been the most economical for this series.

Rotations B and C—for series 68, 66, and 83, the maximum yield in each series was produced where *three 4-inch irrigations* (1.00 ft.) were received by the crop in addition to the rainfall between seeding and harvest (0.58 ft.); where either more or less than this amount of water was applied the yield was less than the maximum. The table on page 16 gives the amount of water received and used in producing the maximum yield of beets in each crop-series. The term "Water Used" represents the amount of water extracted or lost from the soil to a depth of six feet by percolation, evaporation and transpiration and is indicative of the amount of water actually required to grow the crop when these unavoidable soil water losses are taken into consideration. This is ascertained by adding to the water content of the soil at the time of seeding those amounts of water received as irrigation and rainfall and from this sum deducting the amount of water remaining in the 6-foot soil zone at the time of harvest.

In order to better illustrate this, the accompanying graphs have been prepared. The various curves upon these two diagrams, clearly show the procedure that has been followed together with the results that have been obtained in the individual case.

Graph 1 of diagram 1, shows the yields of beets obtained in comparison with the water received and used on seven different crop-series during the season of 1926.

First Crop After Legumes

Graph 2 of diagram 1 shows the yield of beets and sugar per acre as influenced by the number of 4-inch irrigations received for series 48 where beets follow immediately (or first year) after alfalfa in comparison with series 68 where beets follow immediately after red clover. Experiments have indicated that the organic matter, roots, leaves and stems, left in the soil when red clover is ploughed under is more readily converted into available plant food by soil bacteria than is that left when alfalfa is ploughed under. This is because the roots and stems of clover are of a finer texture than those of alfalfa. It is also a fact that a high nitrogen content in the soil, which is brought about by the maintenance of optimum moisture conditions and which produces a maximum yield of beets per acre, favors a low percentage of sugar in the beets, and a low nitrogen content produces low beet yields but a high per cent of sugar. Graph 4, calculated from the mean sugar content of the seven-crop series, illustrates this fact. The per cent of sugar being lowest with 3 or 4 irrigations and highest with one and five irrigations.

Three irrigations produced a per acre yield of approximately 18 tons of beets after clover and but 16 tons of beets after alfalfa, due to the more easily converted clover residue. Three irrigations produced 2.55 tons of sugar per acre after alfalfa and but 2.40 tons of sugar per acre after clover, because of the much higher per cent sugar in the alfalfa soil beets. First year after alfalfa produced most sugar per acre; first year after clover produced the most beets per acre with a given irrigation treatment.

Second Crop After Legumes

Graph 2A shows the yield of beets and sugar per acre as influenced by the number of 4-inch irrigations received for series 46 where beets follow second year after alfalfa in comparison with series 66 where beets follow second year after red clover. Three irrigations produced 20 tons of beets second year after alfalfa and but 19 tons second year after clover. The cultivation and moisture applied to the preceding crop (corn before 66, potatoes before 46) have made possible the elaboration of the plant food locked up in the alfalfa and clover residue so that now the alfalfa soil fertility has apparently increased to a higher beet producing power than the clover, but again with 3 irrigations the per cent sugar in the beet is so much higher after the clover (66) than it is after alfalfa (46) that plot 66C produced .4ton more sugar per acre than plot 46C. These two graphs 2 and 2A, shows that three irrigations, or a total amount of water received of 19 inches, has produced per acre as follows:

	Tons
After alfalfa 1st year sugar	2.55
First year beets	16.00
After clover 1st year sugar	2.40
First year beets	18.00

The fertility built up by a three-year stand of red clover produced slightly more beets and sugar in the next two years following than did that furnished by a five-year stand of alfalfa.

Intervening Cultivated Crop

Graph 3 gives a comparison of series 48, first year after alfalfa with series 46, second year after alfalfa, to show the value of an intervening crop of potatoes between the alfalfa and the sugar beets. Three 4-inch irrigations, plus rainfall, produced 2 tons more beets and .05 ton more sugar per acre for the second crop after alfalfa than for the first. Graph 3A comparing series 68, first year after clover, with series 66, second year after clover, shows that three 4-inch irrigations, plus rainfall, produced .8 ton more beets and .55 ton more sugar per acre for the second crop after clover than for the first. In both alfalfa and clover series, the second year after produced higher yields of both beets and sugar than did the first.

The results shown on diagram No. 1 were obtained under very favorable conditions and, while quite consistent and reliable in themselves, represent however the results of but one season's work, 1926; therefore, in drawing conclusions from the data presented, due consideration must be given to this fact.

Seasonal Water Requirements

7. The amount of water that a sugar beet plant will transpire at any stage of growth will depend upon: (a) the amount of *water* held in the soil zone occupied by its roots; (b) the amount of *energy* as light and heat received from the sun; (c) the relative *humidity* of the atmosphere as influenced by wind, rain, surface evaporation and shade; (d) the area of its leaf and moisture absorbing root surface; and (e) the fertility of the soil or concentration of available soil solution nutrients.

2. The amount of water that is lost to the beet plant by percolation below the soil zone occupied by its roots will depend upon: (a) the texture of the soil, whether coarse and of low water retaining capacity as of sand, or fine and high water retaining capacity as of clay; (b) the amount of water held in the root zone at the beginning of the season; and (c) the depth applied and frequency of irrigation.

3. The amount of water that is lost to the beet plant by evaporation from the soil's surface is influenced by cultivation and shade of plants, temperature, humidity, sun's energy and amount of water in the soil.

	Tons
Second year sugar	2.60=5.15
Second year beets	20.00=36.00
Second year sugar	3.00=5.40
Second year beets	19.60=37.60

When water is introduced into any soil for the purpose of growing a crop, whether as rainfall or as irrigation, it is extracted or lost from the plant's root zone by the three agencies above described. This combined loss represents the losses that of necessity occur in field practice and indicate that amount of water required to produce or grow the crop. These losses are herein referred to as *"Water Used to Grow the Crop."*

Many of the forces that influence the amount of water used in growing a crop are not within our control, such as temperature, humidity, light, general soil texture and to a great extent leaf surface. We are, however, able to control the losses caused by the variation of

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the moisture content of the soil by correct irrigation practice, the losses influenced by varying soil fertility by the use of the proper systems of crop rotations and the losses due to evaporation and extent of leaf surface by seasonable farming operations.

Diagram No. 2 shows the seasonable use of water by sugar beets on plot "C" where in the soil moisture content was maintained at the optimum during the period of growth and, for purposes of comparison, the use of three other plots B, D, and E, where the moisture content throughout the season was not so favorable for growth.

Optimum Soil Moisture Content

Investigations carried out on this soil (fine silt-loam) in 1923 showed that the optimum soil moisture content for wheat was attained when the soil of the root zone contained 2½ acre-inches of water per foot in depth of soil. The small diagram shown to the left of the moisture chart of plot E shows the yield in tons of beets per acre in comparison with a maintained moisture content, through July, August and September, of 1, 2, and 3 acre-inches per foot in depth of soil. The maximum yield of beets per acre, 17 tons, was obtained where the moisture content through this period, and to a depth of three feet, was maintained at 2½ inches. This optimum condition prevailed on plot C, which gave a higher tonnage of beets per acre than did B, maintained through the above period (to same depth as C) at 1.4 inches, D maintained at 1.8 inches; or E maintained at 2½ inches, same as C, but having a more uneven distribution. A study of the moisture charts through the period of greatest growth, and to a depth from which the roots were drawing their main water supply, supplemented by the yields of beets obtained, indicates that the *optimum moisture content for sugar beets on this soil type is 2½ inches of water per foot in depth of soil.*

Seasonable Use of Water

Plot No.	Seasonal Use (inches) Apr.	May	June	July	Aug.	Sept.	Oct.	Yield of beets in tons per acre.	Total depth of water used
C	.2	1.0	2.0	8.0	5.0	3.5	.5	16.8	20.2
E	.6	1.1	3.6	7.0	5.0	1.5	.5	.....	19.3
D	.2	.8	3.5	8.4	2.5	1.8	.0	16.1	17.2
B	.6	.9	5.5	5.5	1.8	1.8	.7	13.0	14.8
Ave.	0.4	1.0	3.2	7.2	3.6	2.2	.4	....	17.9

The summation-use curves for plots 48B, 48C, 48D, and 48E show, by periods, and through different stages of growth, the amounts of water used to bring the beets on these plots to maturity. The data is summarized as follows:

As previously mentioned, the principal variable factors affecting the seasonal use of water on a soil of definite texture and fertility, are, (a) the sun's energy, light, temperature, (b) the extent of the leaf and root area of the plant, and (c) the amount of water in the root zone.

Considering first the influence of the sun's energy on the rate of growth, we would assume that each of the four plots received the same amount, but after a certain date this would not be true as it is only in the green leaves of the plant that this energy can be assimilated and the amount of it assimilated depends upon the extent of the leaf surface of the plant. Up to the end of July, plots C, E, and D had sufficient moisture to provide for ample leaf development and at that time had each a similar area of leaf surface per plant. But plot B received its last irrigation on July second and from the middle of July until harvest suffered to such an extent from a low water content that not only was leaf development stopped but the plant had to protect itself by self-pruning its lower leaves. Where the plant had sufficient leaf surface to receive and utilize it, we find, as shown by the temperature curve, that *this factor—energy—increased in intensity up to the end of July and then decreased to the end of the period of growth.*

Another Important Factor

The amount of water transpired by the best plant will increase as the area of the leaf surface increases. The water supplied to the plant is secured by the porous or uncutinized tips of the fine root hairs. The amount of water secured by the roots in a moist soil depends upon their extent or the area of soil reached by them. Roots secure their energy for growth from the conversion of the foods manufactured in the green leaves. A supply of air in the soil is necessary for this conversion. Therefore, given a proper supply of air and moisture, *the area of the leaf and root surfaces, and consequently the amount of water transpired by the plant, increase from a minimum as the first green leaf emerges from the soil in May to a maximum when the plant is in full leaf in July and August.*

Percolation may account for the larger portion of the moisture lost from the soil zone if excessive amounts of water are applied per irrigation. The maximum amount of water held per foot in depth of soil for any plot was 4½ inches (see the 6th foot in graphs for plots D and E). This may be considered as the maximum capillary water holding capacity of this soil. Any additional water added to a soil zone already containing this amount of water is not retained but lost by percolation to lower soil zones. Plot E (see graph) contained a high water content throughout the season. The 3rd, 4th, 5th, and 6th feet were holding throughout the season so near their utmost capillary capacity that any water percolating to them from irrigations was lost to soil zones below the 6th foot. Plot B had a low water content throughout the season. Very little water reached as far as the fourth foot. *The higher the moisture content of the root zone, the greater the amount of water lost by percolation.* From each irrigation there is some water lost by percolation. This loss of water from the upper soil zones accumulates in the lower zones so long as they are not holding water to their capillary capacity. Thus towards the end of the irrigating season the amount of water in the lower portion of the root zone may have increased to such an extent that percolation loss at this time is much greater than earlier in the season. This is illustrated in the graph for plot C, and will account in part for a higher use of water by this plot in September than the other plots. Plot C was irrigated oftener and later in the season than any other plot. The last irrigation, August 19, raised the content of the 5th foot over one inch.

The amount of water transpired by the plant increases as the amount of water in the soil increases. In plots B and D (see graphs) the transpiration, as effected by the amount of water in the soil, increased to the end of July and then decreased from that date to the end of the season. In plots C and E the transpiration as effected by the amount of water in the soil, remained constant or increased slightly after the end of July. The conditions which favor the most rapid use of water,—extent of leaf and root surface area, amount of water in root zone, amount of heat, light, and energy—gradually increased until they were at their maximum influence in July, and produced a use of 8 acre-inches in plot C. The decrease in energy principally, but also the approach of maturity in the plant, account for a decreased use in August. Plot C used 5 inches in this month. A decided drop in temperature with frost on the 23rd, reduced the use in September to 3½ inches. One-half inch was used during the first seven days in October.

Conclusions

The following conclusions of practical value to the sugar beet grower may be drawn from the data presented in the foregoing text and diagrams:

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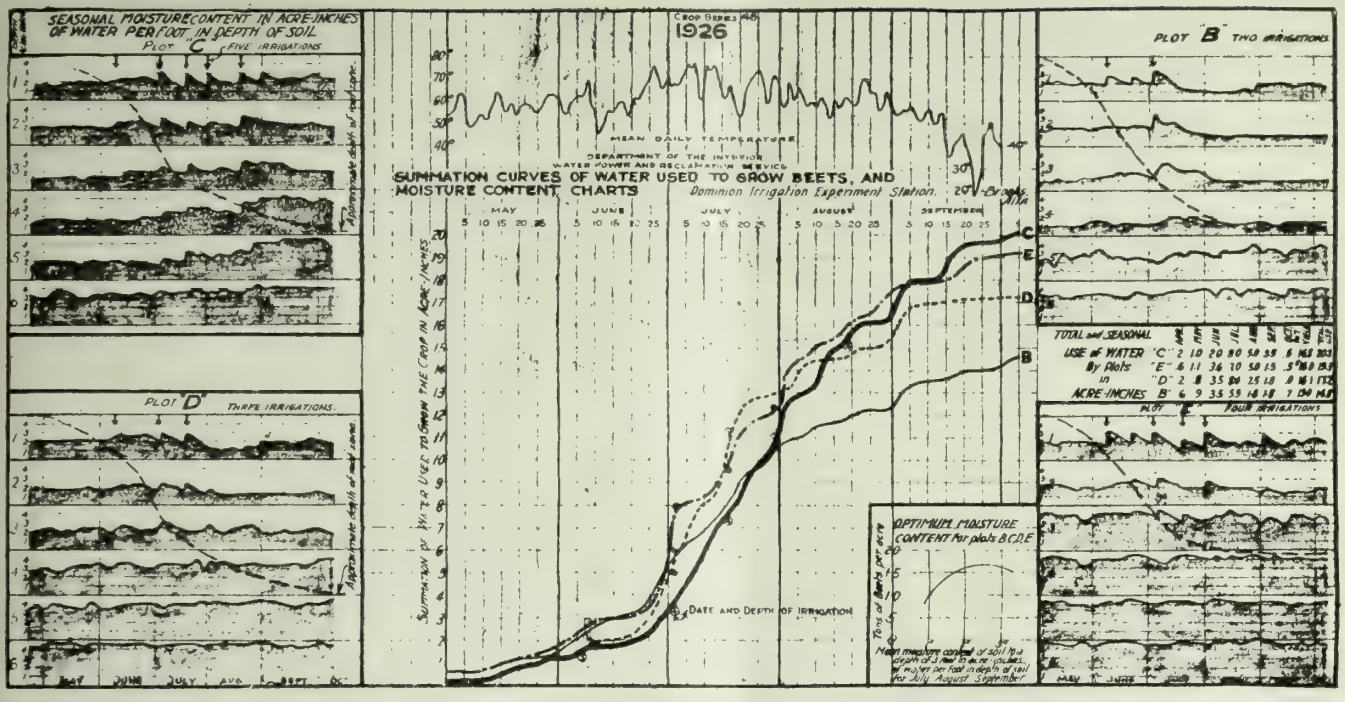
SEASONAL MOISTURE CONTENT IN ACRE-INCHES OF WATER PER FOOT IN DEPTH OF SOIL
PLOT C FIVE IRRIGATIONS
PLOT D THREE IRRIGATIONS
PLOT B TWO IRRIGATIONS
PLOT E FOUR IRRIGATIONS
CROP SERIES 48
1926
MEAN DAILY TEMPERATURE
DEPARTMENT OF THE INTERIOR
WATER POWER AND RECLAMATION SERVICE
SUMMATION CURVES OF WATER USED TO GROW BEETS, AND MOISTURE CONTENT CHARTS
Dominion Irrigation Experiment Station.
MAY JUNE JULY AUGUST SEPTEMBER
DATE AND DEPTH OF IRRIGATION
OPTIMUM MOISTURE CONTENT for plots B.C.D.E
TOTAL and SEASONAL USE of WATER By Plots in ACRE-INCHES
C 2 10 20 30 50 55 6 183
E 6 11 36 10 50 15 5 180
D 2 8 35 24 25 18 9 121
B 6 9 35 55 16 18 7 146

MOISTURE CONTENT CHARTS AND CURVES OF WATER USED TO GROW BEETS, PREPARED BY THE DOMINION IRRIGATION EXPERIMENT STATION

1. Eighteen to twenty acre-inches of water (rainfall plus irrigation plus stored soil water) are required to provide the growing beet crop with an adequate supply of moisture.

2. Of this amount approximately 3 inches will be required up to June 30th, 8 inches in July, 5 inches in August, and 4 inches during the remaining growth period.

3. Soil moisture conditions are most favorable for growth when the pore space or voids of each foot in depth of soil contains from 30 per cent water for fine sandy-loam soil to 40 per cent water for silt-loam soil. This percentage is equivalent to a water content per foot in depth of 1½ acre-inches for fine sandy soil to 2½ acre-inches for fine silt-loam soil.

4. Beet crops at the Brooks station, where supplied with ample water by irrigation, developed their root system chiefly in the first four feet of soil. The dotted curves on the moisture graphs of each plot show the approximate depth of root feeding zone throughout the season. *This zone did not reach the third foot in depth until July* and extended only to the fourth foot during the latter part of the season. Under dry farming conditions or where the water supply is limited, beets will develop roots into the 5th and 6th foot, but to extend and grow, *roots must have air and water.* To withhold irrigation under the mistaken impression that it will force the beet to develop a better root system is poor practice. The roots cannot extend unless they have moisture.

5. A study of the four moisture graphs shows that this soil retained in each foot in depth from 1 to 1½ inches of water from each irrigation. Lighter soils retain from ½ to 1 inch. In average practice the irrigator can supply and retain in the soil about one inch of water per foot in depth of soil.

It is often necessary to irrigate beets about the time of seeding to secure germination, or in May or early June to care for the young plants. The root zone at this time is usually within the first two feet of the surface. The irrigator should therefore apply a very light irrigation, as near two or three inches as possible, because in the first place the root zone cannot retain more, and in the second place excessive irrigation leaches below the root zone the soluble food materials which are less plentiful in the soil at this season, and are so much needed by the young plant. As the season develops and the root zone extends in depth, it will utilize greater depths per irrigation, but at no time have irrigations in excess of four inches proven the most economical.

6. No set rule can be advanced to govern the frequency of irrigation. The root zone must be kept at the proper moisture content by light irrigations. The frequency of these applications will depend upon the rainfall, temperature and growth of the crop. With a rainfall of seven inches during the 1926 growing season at Brooks, the highest yield was obtained on plot C which received a 2-inch irrigation on June 8th, and 4-inch irrigations on July 2, July 17, July 31, and August 19. It must be borne in mind that the surface foot or so is the zone containing the most organic material and soil bacteria. It is the principal nitrate factory of the plant. The soil below this zone may have enough water so that the beet plant secures an adequate amount for transpiration but if the food factory gets too dry the plant's growth is retarded. Plot D had plenty of water in the 3rd and 4th feet, but an insufficient supply in the upper two feet (see graph D). As a result it produced nearly a ton less per acre than C where the upper two feet had an optimum content to the end of the season.

7. To secure the application of light irrigations the supply ditches should be not over from 300 to 500 feet apart. The area irrigated and the stream of water should be measured. The land should be float levelled. The furrows should be straight and well-made.

Progress of Irrigation

(*Continued from Page 10*)

other irrigation and drainage measures have required attention, more than three dozen of which were introduced and about two dozen of which have survived.

The "Commission" Bill (H. B. 115), providing for a fact finding Reclamation Commission, combines the State Irrigation and Drainage Securities Commission with the Desert Land Board under the new name of the State Reclamation Commission. The Governor, Secretary of State, and State Treasurer constitute this commission, with the Governor as chairman and the State Engineer as secretary for the commission. The Governor, with the approval of the commission, is to appoint the State Engineer. The commission is authorized to investigate at the request of any district and go into physical, economic, and financial conditions of the district. Based on results of this investigation, the commission is to make recommendations for the rehabilitation of the district and endeavor to bring together all interests, with a view to formulation of a definite plant and policy under which the affairs of the district may be successfully worked out.

The "Refinance" Bill (H. B. 114) provides for refunding outstanding indebtedness. The district directors by resolution indicate to the State Reclamation Commission their desire to refinance and the commission makes investigation of the district affairs and determines the productive value of the lands with water and the amount of bonds that may be voted.

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The EDITORIAL

MODERN Irrigation

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Vol. III MARCH, 1927 No. 3

Reclamation in 1926

IN 1926 crops valued at more than $60,000,000 were grown on Federal irrigation projects. According to advance figures prepared by the Bureau of Reclamation 1,409,932 acres were irrigated on 24 irrigation projects. Of this area, which included land in young alfalfa and in non-bearing orchards, 1,311,405 acres were cropped, producing crops having a gross value of $60,331,245, or $46 per acre.

In contrast to this figure of $46 per acre on the Federal irrigation projects it is interesting to note that the average value per acre in 1926 of 10 principal crops, comprising nearly 90 per cent of the area in all field crops for the United States as a whole, is estimated by the Department of Agriculture at $19.07.

The very nature of irrigation practice leads to closer settlement and cooperation on the part of the settlers. Each project is dependent on a common water supply, their needs are served through a common main canal, and their mutual interests are necessarily interlinked more closely than in agricultural communities in the humid region. Although there is still room for improvement, cooperative organizations for buying and selling have a firm foothold on most of the projects, and community organization is well advanced.

In 1925 the population of the 37,530 irrigated farms on the projects numbered 136,872, and that of the 203 project cities and towns an additional 365,742. The educational needs of the settlers are well served by 656 schools, including consolidated schools and high schools, and their religious requirements by 645 churches of all denominations. The 146 project banks reported deposits amounting to $125,222,000.

Secretary Work may not have been far from right when he said, "The Bureau of Reclamation has been placed on a sound basis of business efficiency and has been reestablished as a home-making branch of the Government, for which it was originally created."

Two steps must be provided, however, before the United States will be on a par with other countries in their land settlement policies. The first, as Commissioner Elwood Mead recently pointed out, is the furnishing of financial aid, through loans, on long time, at a low rate of interest, in order to supplement the usually meager capital of a settler and tide him over the early years of development, without which he is doomed to years of unnecessary hardship and possible failure in the end. The second is aid and direction of his farming operations by trained advisors, who can help him over the rough places in his farm program, advise him as to the best crop rotation, the kind of crops best suited to the locality, and how they can be marketed to the best advantage.

The need of these two additional steps in our reclamation policy is, we believe, so obvious that it is only a question of time when authority will be granted for incorporating them as a part of the necessary work of the Federal Government in safeguarding its large investment in these public works.

Still No Action

OPINIONS seem to differ somewhat as to just how much value should be placed on the accomplishments of the 69th Congress, but there is no doubt that the failure of that body to take action on the Swing-Johnson bill was a bitter disappointment to those who see in the damming of the Colorado River at Boulder Canyon a development sorely needed for the building of the western empire and a positive necessity for the protection of the Yuma and Imperial Valleys from the menace of floods.

As a matter of fact, much has appeared in the public prints in castigation of the "Fighting 69th" as the last Congress has been called, and very little in support of its method of procedure. The rules of the Congress whereby a minority can prevent a majority from exercising its constitutional right to bring measures to a vote has delayed for the balance of this year any legislative action on Colorado development. Charles G. Dawes, Vice President, and arch foe of filibustering, called attention to the fact that we have the only great parliamentary body in the world where such a situation exists. It is too bad, for not only did Colorado legislation suffer from the filibuster which filled the final days of the recent session, but other legisla-

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POINT *Of* VIEW

tion, perhaps equally important, was shelved, despite the pressing need for it.

Even the fact that Congress might at any time have charged to it one of the most terrible flood disasters of these times if it failed to take action on the Swing Johnson bill, did not have the effect of bringing the desired action on the bill, although Secretary Work and others who are cogniziant of the menace of the Colorado to the Imperial Valley did their utmost to impress the gravity of the situation on the legislators' minds.

It remains to be seen whether the temporary levees which now protect the Imperial Valley from Colorado flood waters will serve as sufficient measures for protection from the floods of next summer. There is no question but what a reservoir to hold back floods on the Colorado and increase the low-water flow is an imperative necessity. The menace grows year by year because the river is building up its channel through the deposit of the 100,000 acre-feet of silt carried down each year by its sediment laden waters. This means that the levees must be raised higher and higher and that as a consequence the danger of their failure becomes greater and the consequences of a break more dire.

When one considers that legislative action on Colorado River development has been withheld in spite of this ever-increasing danger, one wonders what the men who make our laws will think about it if the dreaded danger becomes a reality. It would be a terrible thing for those most responsible for the failure of the river legislation to carry on their consciences the rest of their lives and there would be small consolation for those who gave warning to be able to say "we told you so."

That a development so essential to the upbuilding of a great section of this country can be delayed now and again because of sectional jealousies and petty politics is deplorable, but when such development is blocked in spite of the apparent danger to life and property of thousands of people the delay is little short of criminal.

Credit to the Pioneer

CONSIDERABLE interest attaches to the action of the society of Engineers of the San Francisco bay region in creating a committee to conduct research work to determine the outstanding figures in the history and development of water engineering, railroading, highway construction, electrical energy and land surveys in the State of California.

The work is expected to take the greater part of the present year. Under the plan, effort will be devoted to seeking out the prominent men, especially pioneer engineers, and make their names and work known to the public generally. Such information in the form of manuscripts, reports, photographs, personal and professional history and other such data as can be obtained will be placed in the Bancroft Library at the University of California.

It is also the intention of the committee to endeavor to have placques placed and other markings erected in whatever locality the person honored had lived and carried out his or her best work in the interests of the state.

The Society was led into this work by the more or less accidental discovery that it was Col. Leandro Ransom, first representative of the Federal Land Surveys in California, who laid the foundation of all California surveys, when he established what is known as the "Mount Diablo base and Meridian" in the year 1851. In recognition of this work, the Society of Engineers has dedicated a spur on Mount Diablo as Ransom Point. This has since been officially recognized by the United States Geographic Board, and a bronze plate will soon be placed there.

Mr. Leurey has associated with him as committeemen Glen B. Ashcroft, R. C. Briggs, Hans Graff and A. E. Zimmerman. The president of the Society George E. Tonney under whose leadership the work is progressing has been quite active in the success of the movement.

The Society's plan must be considered a worthy undertaking. Some of the greatest engineering achievements have passed almost unnoticed outside the profession. A more general appreciation of the engineer's service is an end to which organizations such as this one well may strive.

Bring in the Neighbors

DIRECTORS of the California Section of the American Water Works Association are scheduled to pass on a proposition of major import at their meeting at San Jose on March 26, announcement having come from the office of the secretary that the expansion of the district to include Washington and Oregon will be acted upon at that time.

It will be recalled that special invitations were extended to waterworks engineers in neighboring states to attend the annual convention of the California Section at San Diego last fall. The response was prompt and enthusiastic and there can be no question but what it was good for the Californians to meet these neighbors and exchange ideas and views. Distances are so great in the west and the average waterworks engineer is so busy in his own sphere of activity that only through such an opportunity as the convention offered last fall can he learn what the other fellow with similar problems is doing to solve these problems.

All of the territory contiguous to the Pacific Ocean has conditions with aspects of such similarity that a yearly discussion and interchange of views, such as the annual waterworks convention offers, cannot help but prove of considerable practical value. The proposition to expand the district to include Oregon and Washington has real merit and we believe favorable action of the directors at their coming meeting will meet with the approval of the membership generally.

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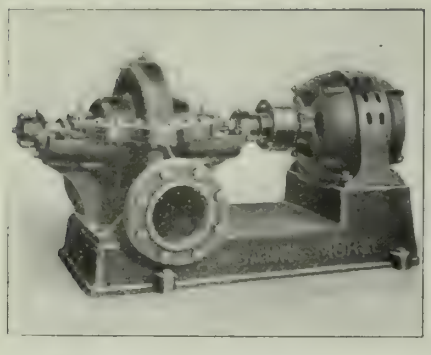

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Story of the Rio Grande Irrigation Project

(*Continued from Page 13*)

Comparison of Discharges and Sediment Content

Rio Grande at San Marcial, New Mexico, and El Paso, Texas, showing effect of storage by Elephante Butte Reservoir, completed in 1915

Place	Max. Discharge in Sec. Feet	Maximum Annual Runoff in Ac. Ft.	Mean annual silt content in Ac. Feet
Before Completion of Storage Dam			
San Marcial, New Mexico	Oct., 1904 33,000	1895 to 1926 2,422,008	19,000
El Paso, Texas	June, 1905 23,683	1899 to 1914 2,011,794	15,300
After Completion of Storage Dam			
El Paso, Texas	Sept., 1925 13,800	1916 to 1926 888,198	440

Note—San Marcial is at head of reservoir.

The soils of the project consist of generally fertile alluvial material laid down by the Rio Grande, ranging from sand to adobe and graded to the conditions under which it was deposited. The sandy sub-soil responds quickly to drainage and the solubility of the white alkali salts makes it possible to quickly remove them by leaching. The soil and climate will grow practically any temperate zone crop. Cotton and alfalfa are the standard field crops. The average yield of alfalfa is about 4 tons to the acre and the average for cotton is slightly less than 1 bale to the acre. Other crops such as winter wheat, corn, cane, beans, melons, cabbage, onions, lettuce—all are successfully grown.

At the inception of the project most of the lands were in private ownership and only a few hundred acres of Government land existed in the New Mexico portion for acquisition under the Homestead and Reclamation acts. The ordinary difficulties of proper settlement have been overcome by the natural normal growth of the project and through the activities of the Chamber of Commerce and settlement bureaus.

Administration

The Bureau of Reclamation of the United States Department of the Interior has been in charge of construction and operation of all project irrigation and drainage features. The project construction costs including storage, diversion dams, main canals, laterals, and drainage works, is $90.00 an acre, which is repaid in graduated payments by the land owners under present contracts in twenty years without interest. The cost of operation and maintenace is repaid annually and averages approximately $2.25 per acre for the average use of approximately 2 acre-feet of irrigation water.

Two irrigation districts are formed under state laws; one for the New Mexico lands, called the Elephant Butte Irrigation District, and one for the lands in Texas, called the El Paso County Water Improvement District No. 1. Each of these districts guarantees to the Government the collection and repayment of construction and operation and maintenace costs.

The Rio Grande Federal Irrigation Project is one of the most successful Federal irrigation projects in the program of western land reclamation. Not only has it resulted in a large increase in county, state, and national wealth,

Settlement and Irrigation Project

Rio Grande Federal Irrigation Project

	1917	1918	1919	1920	1921	1922	1923	1924	1925
Acres irrigated	64,308	64,781	70,012	73,346	85,580	89,589	92,220	116,000	131,000
Miles canal operated	86	153	385	546	586	645	808	926	950
Number farms	1,700	2,287	2,700	3,021	3,222	3,534	3,743	4,119	4,442
Water deliv. to farms in Ac. Ft.	7.	6.15	2.5	2.95	2.55	2.28	2.18	2.18	2.16
Av. per acre gross value crop yield	$51.50	66.20	50.20	59.57	32.13	53.06	88.76	93.34	87.66

Note—Table does not include lands in Mexico or Hudspeth County, Texas.

"Western Waterworks" Begins on Page 25

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producing millions of dollars annually in crop values, but the organized efforts of the land owners have resulted in meeting the repayment obligations to the Government promptly and producing a valuable community spirit and credit.

Crops From Federal Projects in 1926 Worth $60,000,000

Crops valued at more than $60,000,000 were grown last year on the Federal irrigation projects under the Bureau of Reclamation, it was announced by the Interior Department in January.

According to advance figures prepared by the Bureau of Reclamation 1,409,932 acres were irrigated on 24 irrigation projects. Of this area, which included land in young alfalfa and in nonbearing orchards, 1,311,405 acres were cropped, producing crops having a gross value of $60,331,245, or $46 per acre.

In contrast to this figure of $46 per acre on the Federal irrigation projects it is interesting to note that the average value per acre in 1926 of 10 principal crops, comprising nearly 90 per cent of the area in all field crops for the United States as a whole, is estimated by the Department of Agriculture at $19.07.

Montana Water Bulletin

The Department of the Interior, through the Geological Survey, has recently issued as Water-Supply Paper 580-B a brief report entitled "Water Power and Irrigation in the Jefferson River Basin, Montana," by J. F. Deeds and W. N. White, which contains a discussion of present and potential water power and irrigation development in the area. The report is illustrated by a map of the region showing the location of irrigated and irrigable lands as well as power and reservoir sites and also contains a summary of all available water-supply data obtained at the stream-gauging stations operated in this basin by the Geological Survey.

Sutherland Dam Award Made

The city council of San Diego, California, has awarded the contract for the new Sutherland dam to Edwards, Wildey & Dixon Company, of Los Angeles, whose bid of $896,742.55, was the lowest of more than a dozen submitted. Work is to be started at once on the preliminary plans for the construction of the huge dam. According to the successful bid, the dam, a multiple type structure, will be completed by June, 1928, and will be paid for out of the $2,000,000 bond issue recently voted by the citizens of San Diego.

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Novel Motor Installations

Special induction motors are built for vertical irrigation pumps of turbine or centrifugal type, the Westinghouse Electric and Manufacturing Company states in a recent bulletin. These motors have hollow shafts through which the pump shafts project. The motor and pump shafts are connected together by a clutch at the top of the motor. Important advantages are easy adjustment and alignment of the pump impeller, elimination of whipping action at upper end of pump shaft or damage due to momentary reversal of the motor during a power failure. Special windings obtain a low starting current when the motors are started at full line voltage. Relatively high starting and pull-out torques are obtained, with an efficiency and a power factor at full load approximately those obtained with standard motors.

One of the largest electrically driven clear water pumping stations in existence is that now being installed at Kansas City, Mo. This plant will include two 2000 hp. 13,200 volt, synchronous motor driven, 24,000,000 gallon per day, high lift, centrifugal pumps; and eight 400 hp., 2200 volt, synchronous motor driven, 36,000,000 gallons per day, low lift pumps.

Sewage systems formerly had very little moving machinery, but as pollution of streams becomes more serious, disposal systems are being installed, and these call for extensive motor drives, with control which is sometimes elaborate. The semi-automatic control the company has furnished to the city of Trenton, N. J. is of special interest.

Three 60 hp. squirrel cage and three 75 hp. wound rotor 2200 volt 60 cycle vertical motors driving centrifugal pumps are controlled by a single float in the pump well. At each one inch increase in level in the pump well the speeds of the pump motors are changed or signals given to the operator to start or stop additional pumps. Starting with a minimum capacity and one wound rotor driven pump, it is automatically brought up to full speed, then for additional capacity a signal is given for the operator to start a constant speed motor. When this is started the wound rotor motor is automatically slowed down to the proper speed and then again brought up to full speed with further increase in sewage flow. At this point a second constant speed motor is started by the operator, the previous cycle is repeated and a third constant speed motor started and later the second wound rotor.

For decreasing flow in sewage th operations are reversed. It is not necessary for the operator to do any special switching to change the sequence of the pumps so as to keep the wear on them the same. He simply starts the pump he wants to use and the control does the rest.

Two of the largest horizontal waterwheel type generators ever produced by Westinghouse are being built for the Southern California Edison Company. Each will rate 50,000 kv-a. at 60 cycles, 300 rpm., and 45,000 kv-a. at 50 cycles, 250 rpm.

Geologist Favors Fork Site

(*Continued from Page 11*)

gineering should provide. I should have no such apprehension with regard to a dam at the Forks site. There is no suggestion of a fault traversing it and it is several miles further removed from the master fault at front of the range.

There are several other faults in the zone of cross-faults upon which the Granite Dike dam would rest, but the Granite Island fault appears to be the principal one. The considerations which flow from its existence would apply to the others, although they are not so impressive as lines of dislocation. In general I would say there is more risk of accident at times of heavy earthquake at the Granite Dike site than at the Forks site, and on the principle that, in the construction of a high dam above a populous valley, no risk whatever should be taken that can possibly be avoided, I recommend the adoption of the Forks site in preference to the Granite Dike site.

Los Angeles Heads Water List

According to a recent statement of R. F. Del Valle, president of the board of Water and Power Commissioners of Los Angeles, the municipal water system serving Los Angeles is the second largest in the country. Del Valle also stated that the city's municipally owned electric system was the largest so owned in the nation. New York is the only other city in the country, it was pointed out, which possesses a water plant larger in extent of distributing mains and water supply and storage facilities than the system owned and operated by the Los Angeles Municipal Water Bureau.

Charles D. Marx, professor of civil engineering of Stanford University, Charles H. Lee, consulting engineer, San Francisco, and Harold F. Gray, hydraulic engineer, Berkeley, have been appointed by the city council of Oakland to investigate the storm sewer problem.

"Western Waterworks" Begins on Page 25

WESTERN Waterworks
Supplement to Modern Irrigation
Of Interest Expressly to Waterworks Executives, Contractors, and Municipal Engineers

Formulate Standards for Swimming Pool Design, Construction and Operation

American Public Health Association Announces Working Principles as Guide for Nation's Waterworks Engineers*

DURING the past six years separate Committees on Bathing Places of the Public Health Engineering Section of the American Public Health Association and of the Conference of State Sanitary Engineers have been very largely identical in personnel, and have worked practically as a single body making separate though similar reports each year to both organizations. At the meetings of both organizations in 1925 it was voted to unite these two separate committees into a joint committee representing both bodies.

At the time when these committees were instituted the practice as to construction, equipment and operation of swimming pools varied widely in different states and in different communities within the state. Furthermore, although it was beginning to be recognized that certain diseases might be spread through the medium of improperly conducted public bathing places, the control measures necessary to insure proper cleanliness and sanitation had not been formulated.

In previous reports the committee has presented certain evidence as to the causation of various transmissible diseases by the waters of poorly constructed and equipped or improperly operated swimming pools, by bathing in polluted waters and by the use of incompletely sterilized bathing suits and towels, and the need of improved bathing place sanitation throughout the country. In the 1923 reports the committees proposed certain tentative standards for the physical, chemical, and bacterial quality of swimming pool waters together with certain operating regulations for the maintenance of those standards. In the 1925 reports the committees presented information as to the measures necessary for the safety of bathers and for the prevention of accidents.

Committee Correlates Data

During recent years there has been a widespread demand that the committee correlate the data included in its reports with other unpublished information which has accumulated in its files and formulate a standard code of bathing place sanitation. In compliance with this demand the report of the joint committee to the conference of State Sanitary Engineers in May, 1926, proposed a rather complete code of standards for the design, construction and equipment of swimming pools together with certain standards for other bathing places.

With certain minor changes which have seemed advisable following discussion at the conference and from the comments received from swimming pool designers, makers of swimming pool equipment, and others, and with the incorporation of the tentative standards of water quality, etc., presented in the 1923 report of your Committee on Bathing Places, we now offer the appended code of Standards for the Design, Construction, Equipment, and Operation of Swimming Pools and Other Public Bathing Places, for the consideration of this section.

Committee's Recommendations

In accordance with the usual procedure in the preparation and adoption of standards, the committee would recommend:

1. That the appended standard code be approved in principle as a whole by this action.
2. That these standards be referred back to the Committee on Bathing Places for such minor correction and revision as may be advisable.
3. That the committee be instructed to present a final report on standards for adoption at the next meeting of this section.

Standards for Design, Equipment, and Operation

Classification of Bathing Places

A. The term "bathing place" as used in this report includes all bodies of water sufficiently deep for complete immersion of the body and used collectively by numbers of persons for swimming or recreative bathing, together with the shores, buildings, equipment, and appurtenances pertaining to such bathing places. It does not include public or semi-public baths, where the main object is the cleansing of the body or the practice of the healing art, unless such baths

*Report of the Joint Committee on Bathing Places of the A. P. H. A. and the Conference of State Sanitary Engineers, presented to the Public Health Engineering Section of the American Public Health Association at the Fifty-fifth Annual Meeting, at Buffalo, N. Y., October 12, 1926.

THE LOS ANGELES ATHLETIC CLUB POOL, LOS ANGELES, IS OPERATED VERY EFFICIENTLY AND ACCORDING TO THE PUBLIC HEALTH OFFICIALS IS ONE OF THE MOST SANITARY POOLS IN THE CITY.

contain pools or tanks used collectively by a number of individuals.

B. Bathing places may be divided into three classes:

1. Natural outdoor ponds, rivers, tidal waters, etc.
2. Outdoor pools which are partly artificial and partly natural in character.
3. Pools outdoor or indoor which are entirely of artificial construction.

Natural ponds and rivers are necessarily dependent upon natural flow or upon wind and wave action for circulation of the water. Artificial and partly artificial pools may be divided into four classes according to the method by which water cleanliness is obtained.

a. Large semi-artificial pools in which the water cleanliness is maintained by natural flow or circulation.

b. Fill and draw pools where cleanliness of water is maintained by complete removal and replacement of the water at periodic intervals.

c. Flowing through pools where cleanliness is maintained by circulation of water through the pool from some natural or artificial source, but where the outflowing water is wasted.

d. Recirculation pools in which circulation of the water is maintained through the pool by pumps, the water drawn from the pool being clarified by filtration before being returned.

Principles of Sanitation

A. In the control of swimming pool and bathing place sanitation certain broad principles apply to all classes of public bathing places.

B. The committee is of the opinion that all public bathing places both natural and artificial should be under the sanitary control of the public health authorities.

C. In the opinion of the committee the same standards of cleanliness and bacterial purity of the water and the same precautions against the possible spread of disease should apply at both indoor and outdoor swimming pools.

D. The requirements should be the same for all artificial and semi-artificial pools whether located indoors or outdoors, so far as the features of design and equipment apply to maintenance of cleanliness of the pool and of the water with which it is filled.

E. At public bathing beaches on natural waters the same sanitary standards should apply to bathing houses, dressing rooms, toilet facilities, and to the handling and care of bathing suits, towels and other articles of bathing apparel as would be required at artificial swimming pools.

F. Sanitary drinking fountains with a supply of pure water should be installed at all bathing places. The common use of towels, drinking cups, combs, hair brushes, or other toilet articles should be strictly prohibited.

Location and Layout

A. The location of an outdoor pool will be governed largely by local conditions; and arrangement of dressing rooms, etc., can be made to conform to the sanitary requirements. In locating an indoor pool careful study must be given to architectural and engineering features in order that the proper layout may be obtained.

B. The layout or arrangement of entrances and exits of the pool room in relation to dressing rooms, showers and toilets must be such as to enforce proper routing of bathers. Coming from the dressing room a bather should be required to pass the toilets, and go through the shower room before arriving at the pool entrance. Bathers should leave the pool through a separate exit leading to toilets and dressing rooms.

C. At pools used simultaneously by both sexes separate entrances and exits should be provided for men and women. There should be no connection between men's and women's quarters.

D. Entrances and exits must be located at shallow water portion of the pool.

E. If pool is to be of recirculation type, ample room must be provided for filters and other units. All recirculation piping, inlet and outlet valves, etc., must be located where they will be readily accessible.

F. At indoor pools where liquid chlorine disinfection is to be used, it is recommended that the chlorine apparatus be located in a glass enclosure in the pool room in order that dosage may be under the immediate supervision of the pool attendant.

Design and Construction

A. *Material:* Any material which will provide a tight tank with smooth and easily cleaned surfaces may be used for artificial swimming pools.

B. *Details of Design:* The details of design in so far as they relate to strength of material, waterproofing, etc., are essentially the same as in design of other tanks of similar size and shape and are, therefore, omitted from this report.

In the design of a new pool provision should always be made for complete circulation of water through all parts of the pool during the bathing period. Without proper circulation it is difficult or impossible to maintain good sanitary conditions at all times, even though the pool be completely emptied, cleaned, and refilled each day. The installation of new fill and draw pools cannot be recommended.

C. *Shape:* Indoor pools should be of rectangular shape with deep water at or near one end and shallow water at the other. Small outdoor pools should be of same general design as indoor pools. The best shape for large outdoor pools depends largely on the size and on local conditions. It is considered better practice to build large pools with the deep water area in the center.

D. *Dimensions:* For swimming records a straight away course of at least 60 feet with 5-foot lanes is required. Length

of pool should be not less than 60 feet and width should be some multiple of 5 feet. The area to be provided for the expected bathing load is discussed in a subsequent chapter.

E. *Depth of Water:* The minimum depth of water in the deep portion of any public pool should be not less than 6 feet.

F. *Proportion Deep and Shallow:* Some authorities recommend that the area of shallow water, 5 feet or less in depth, should be 80 per cent or more of the total area of large outdoor pools. Such proportioning must be considered in relation to the pool volume, the bathing load, the recirculation or flowing through purification system, etc. The committee has insufficient information on this point to warrant any recommendation at the present time.

G. *Slope of Bottom:* The slope of the bottom of any part of a pool where the water is less than 6 feet deep must not be more than 1 foot in each 15 feet. There should be no sudden changes of slope within the area where water depth is less than 6 feet.

H. *Side Walls:* The side and end walls of all artificial and semi-artificial pools should be vertical. Sloping side walls are dangerous and cannot easily be kept clean.

I. *Pool Lining:* Including bottom and sides up to runways lining must be of white or light color material and present a smooth finished surface without cracks or joints. All corners must be rounded. Tile or glazed brick lining is recommended for all indoor pools and for small outdoor pools. White cement smoothly finished is satisfactory for large outdoor pools. Dirt does not show on asphalt or other similar dark material and such materials are not suitable for pool lining. The use of paint or similar material to obtain a light colored finish is not satisfactory and should not be permitted. Sand or earth bottoms cannot be kept clean and are not recommended for pools.

THE JONATHAN CLUB POOL, LOS ANGELES, HAS JUST RECENTLY BEEN PLACED IN OPERATION. THIS POOL ALSO HAS A FINE SANITATION RECORD, AND IS ON A PAR WITH THE OTHERS OF ITS TYPE IN THAT CITY.

J. *Markings:* It is recommended that swimming lanes be marked on the bottom with dark colored material of the same kind as pool lining. The outlet of the pool should also be plainly marked by a black or dark colored circle, unless outlet grating is of conspicuous coloring. The depth of water at the deepest point and at the 5-foot point should be conspicuously marked on both sides of a pool with deep water at one end. Markings showing depths in 1-foot increments are desirable. In large pools with deep water only in the middle the 3- and 5-foot depth line should be conspicuously marked on the bottom and also designated by surface floats.

THE PASADENA MUNICIPAL POOL IS ONE OF THE MODEL OUTDOOR SWIMMING POOLS IN CALIFORNIA. THIS IS ONE OF THE FEW ESTABLISHMENTS WHICH IS OPERATED ACCORDING TO THE SPECIFICATIONS OF THE A. B. H. A. AND THE MANAGEMENT SHOWS A NICE PROFIT AT THE END OF EACH YEAR.

Proportioning Area to Load

A. In the design of an artificial pool due allowance must be made for the number of bathers who may be expected at the time of maximum use. In computing the area which must be provided it is recommended that the pool be divided into three zones, and the area of each computed separately.

B. From the data collected by the committee for its fifth report it was the consensus of opinion that an area extending 10 feet from the extremity of a diving board or tower should be considered as reserved for divers, and that not more than two or three persons should be permitted in the water in this area at one time while diving is in progress. About three times that number will be on the shore or diving platform awaiting their turn to dive. Twelve persons is therefore the maximum number which may be permitted for the area within 10-foot radius of each diving board or platform.

C. It was the consensus of opinion of swimming pool operators that the space required by a swimmer might fairly be expressed as five-fourths the square of his height and that on an average two-thirds of the swimmers present would be in the pool at the same time. On this basis the average space requirement for an adult swimmer is 36 square feet and allowing for one-third of swimmers on the shore, an average of 27 square feet

(*Continued on Page 48*)

This New Rig Meets Stiff Requirements Imposed by Deep Well Drilling

By H. C. DICKEY
Engineer, Roscoe Moss Company

A LARGE percentage of western municipalities derive their water supply from the sub-surface waters, and so during the last few years have been confronted with the problems of lower water tables, insufficient supply, and the many troubles that accompany a prolonged dry period. The continuation of their supply has been dependent upon wells, and the art and science of water well drilling in the West has reached a point of development of which our eastern states have only a vague idea.

If the present era of stream and ground water pollution is maintained it will be necessary for all cities to resort to producing water from underground strata, thereby obtaining pure water due to filtration through the overlying ground. To produce the quantities of water necessary, large wells will be required and it therefore becomes apparent that a portable drilling rig capable of drilling 30-inch diameter holes 1200 feet deep is absolutely necessary.

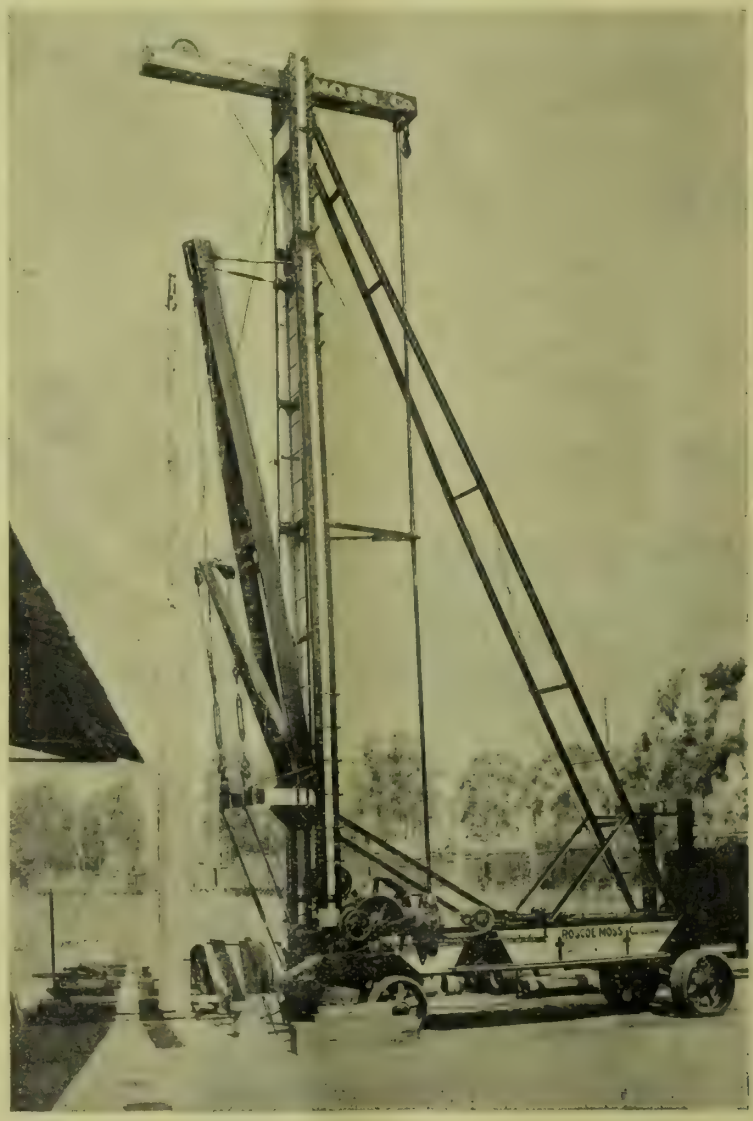
Due to the demand for water, the fall of the water tables in various sections of California has been very noticeable, and this, too, is necessitating deeper wells.

To drill such wells, larger and heavier drilling rigs have been required, but as locations for wells often are hundreds of miles apart, a mobile piece of machinery is required in order to eliminate as much lost time as possible in traveling from one location to the next; and as many locations are in soft or sandy fields, or in stream beds, the drilling rig must be as light as possible, and also must be kept well within the load limit of present concrete roads.

In order to meet all these requirements, a drilling rig has been designed and recently completed embodying many up-to-date engineering principles.

This rig, weighing 12 tons, is mounted on a five-ton Timken front axle with special 36-inch by 8-inch Kay cast steel wheels, equipped with 36-inch by 10-inch solid tires. These wheels were fitted with extra large size Timken bearings and 3½-inch by 9-inch leaf Silico steel springs. The rear wheels, 40-inch by 14-inch Kay cast steel, were fitted with extra large Timken bearings, mounted on a 7½-ton Mack solid rear axle, and carrying 5-inch by 14-inch leaf full floating springs, and equipped with 2 40-inch by 8-inch solid tires on each wheel.

With this equipment the rig was kept rolling at 13½ miles per hour for two hours without any signs of heating the bearings.



A CLOSE-UP OF THE NEW DRILLING RIG WHICH MEETS THE REQUIREMENTS OF DEEP DRILLING AND YET RETAINS EASY PORTABILITY AND SPEEDY OPERATION.

The draw-works of this rig is particularly noteworthy, in spite of the many new features of design including all ball bearings and multiple disc clutches mounted on ball bearings.

Many times during a day's drilling the mud scow is run to the bottom of the hole. On a 500-foot hole the mud scow will make the trip to the bottom in two minutes, thereby revolving the loose section of the clutch at the rate of 700 R. P. M. As this is running in the opposite direction to the main shaft, traveling at a rate of 150 R. P. M., it means that the rate of speed is 850 R. P. M. within the clutch. As this has formerly been taken care of with a narrow brass bushing much wear has resulted. On account of the fixed width of all rigs, viz., 54 inches, it has not been possible to install a wider bushing. When a bushing started to wear, it allowed the clutch to lag over, thereby dragging, using engine power, and causing considerable other trouble.

To eliminate all these troubles, a multiple dry disc clutch, mounted on

two 5217 S K F rigid ball bearings, was designed. These multiple disc clutches are faced with 324 square inch of woven sanded clutch facing, mounted on a 12-tooth spline cut from the solid shaft. The sliding brasses are split in half to facilitate replacement when the wear becomes noticeable. The gears in all cases were cast integral with the clutch bowls and are a heat treated chrome alloy cast steel, thereby insuring long life and maximum strength for the weight involved.

The pump is driven by a multiply dry disc clutch mounted on two 5315 S. K. F. rigid ball bearings, with a 13-tooth sprocket (A. P. I.) and No. 3 design cast on the bowl.

The main shaft, 3⅜-inch diameter by 6 feet and 7½ inches long, carrying the pump, drilling and hoisting drum clutches and the band wheel, is mounted on two 21316 S. K. F. self-aligning roller bearings.

Another Problem Solved

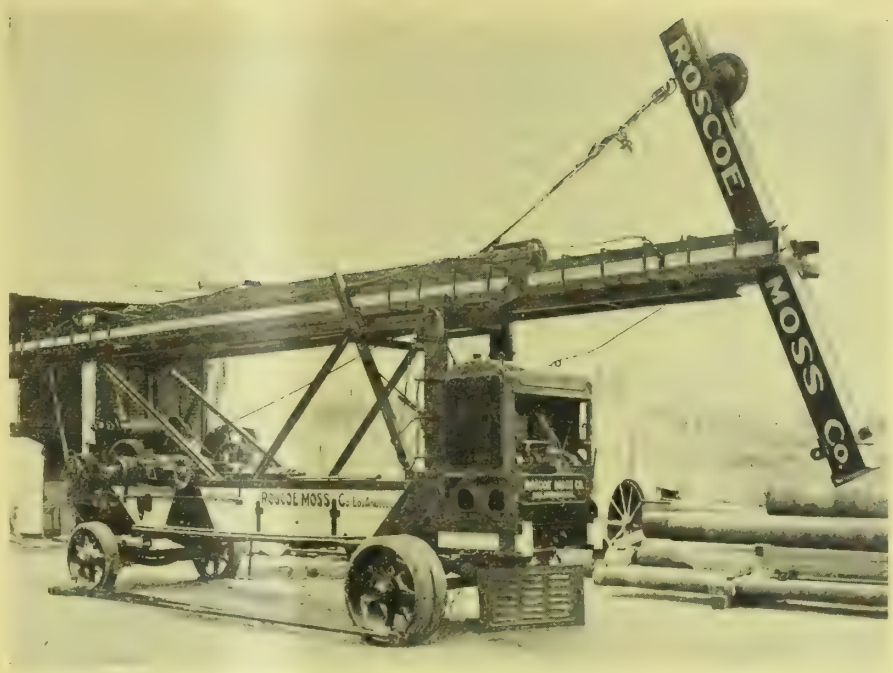
One of the principal sources of worry in a portable rig is the considerable amount of wear on the main draw-works bearings. In order to keep the weight of the rig as low as possible, 4-inch side timbers are used for the chassis of the rig. This arrangement means that all of the main frame bearings cannot be wider than 4 inches, and this width is far too little for the loads involved. It is almost impossible to build a frame work that will not weave and move when drilling, as the sudden strains and shocks are enormous. This movement, coupled with the large loads, causes considerable wear on the main bearings which soon allows movement and play throughout the machinery.

To overcome this, self-aligning roller bearings were used, packed in an oil-tight chamber and mounted in a single casting containing the main drum bearing, brake shaft bearing and the crank shaft bearing.

By placing all four side bearings in one casting, the center distance of the gears is maintained and all wear due to improperly meshed gear teeth is eliminated. The hoisting drum, with a spooling capacity of 1300 feet of ¾-inch wire line, is mounted on Series 9500 Timken bearing; the shaft being held rigidly by the side bearing castings eliminates another source of bearing trouble. The brake shaft is mounted on one 23314 S. K. F. self-aligning roller bearing to carry the overhanging brake and the other end is encased in a housing containing a No. 411 S. K. F. self-aligning ball bearing.

Other Construction Details

The brake 16 inches in diameter and 5 inches wide, provides ample capacity to stop in four seconds a 3000-pound string of tools travelling 750 feet per minute. The brake is provided with a ratchet stop arrangement mounted on two opposed Timken roller bearings.



A VIEW OF THE NEW DRILLING RIG FOLDED FOR TRANSPORTATION

The sand reel with a capacity of 1200 feet of 7-16-inch line is mounted on two opposed Timken bearings riding on this shaft. The clutch bowl and sand reel are cast integral and the outside of the clutch bowl is used for the brake. One end of this shaft carries a constantly revolving cathead.

The mast, towering 43 feet, 8½ inches above ground level, is built of 4-inch by 12-inch Oregon pine dressed timbers 37 feet, 6 inches long. The corners are protected by 4-inch by 4-inch by ¼-inch angles and 6-inch channels are used for spacers.

The walking beam, 13 feet, 7½ inches long, is built of 10-inch, 30-pound channels, fitted with a solid piece of dressed oak. This walking beam mounted on a rocker that slides in two guides made of 12-inch ship channels, is mounted on four heavy double box car springs.

To eliminate friction, thereby adding to the speed of the rig, and to decrease the wear on the drilling line, all sheaves are of manganese steel mounted on Timken roller bearings. One of the principal sources of the wear of drilling lines is caused by the sheaves wearing out of groove, thereby permitting the line to flatten itself every time it goes over the sheave.

Manganese is the best wear resisting metal for these sheaves and when mounted on Timken bearings, there is very little chance for the sheave to bind and cause the line to slide through the groove.

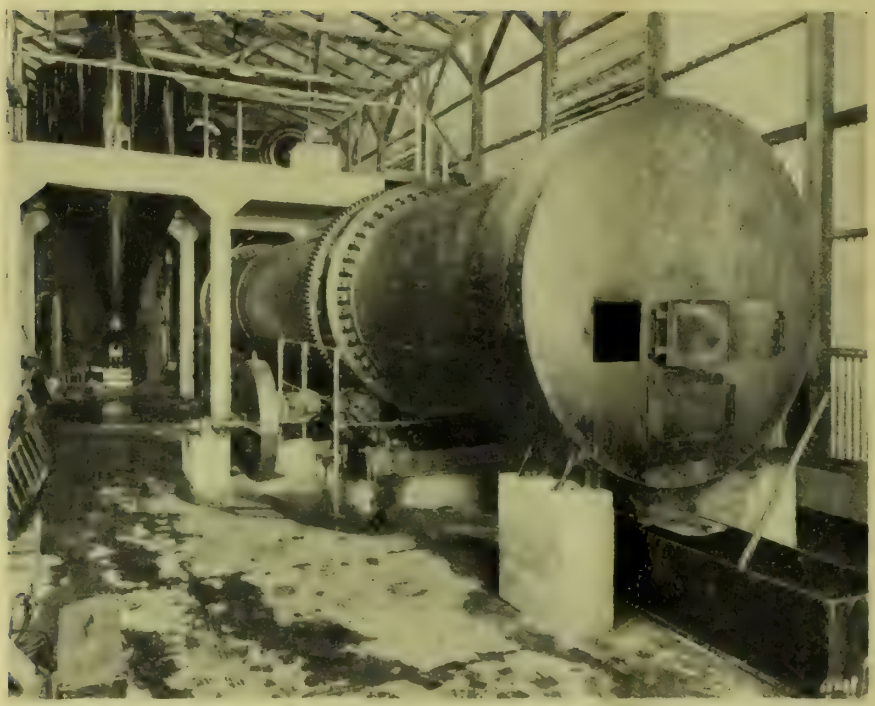
The mast is hung from a 2 15-16-inch shaft near the top of the Samson post. Pivoted on the same shaft is a welded steel mast 22 feet long, over the end of which the sand line is operated. Pivoted on the same shaft is a third welded steel mast 10 feet long.

In setting up the rig, the small 10-foot mast is first raised by hand, as it weighs only 175 pounds and is pivoted at one end. This is a fairly easy matter for the driller and his helper. With this mast set up, the upper end is tied down to the end of the outrigger platform and the sand line is reeved, from the sand reel to a 6-inch double sheave at the top of this mast and then to a 6-inch single sheave about 14 feet up on the second or sand line mast, and back to the double sheave and then back to a dead end on the sand line mast.

The main drilling line is then reeved from the drum over the main idler sheave to the 14-inch sand line mast single sheave and back to the second idler shaft sheave and back to a dead pull at the top of the sand line mast.

With the sand reel, the second or sand reel is raised until it is about 2 feet 8 inches past the vertical towards the front of the rig. As this mast raises, the main drilling line is paid out, thereby preventing the mast from falling over the front of the rig. When the sand mast is finally in position, it is guyed to the outrigger platform with a 1⅛-inch blue center line stay and the mast is raised to a vertical position by the main line drum. When vertical, the wood chucks at the bottom of the mast are put in and drawn up tight with bolts

(*Continued on Page 47*)



COMMERCIAL FERTILIZER IS OBTAINED BY DRYING THE DE-WATERED SLUDGE. THE SLUDGE, AFTER LEAVING THE OLIVER FILTERS IS DELIVERED TO THE ROTARY KILN, SHOWN ABOVE, WHERE THE MOISTURE CONTENT IS REDUCED TO A NEGLIGIBLE QUANTITY. THE CAKE IS THEN SUITABLE FOR COMMERCIAL USE.

The Uses of Modern Mechanical Equipment in Sewage Treatment Systems

THE disposal of sewage and industrial wastes has become a problem of such serious national importance that the whole subject is being given a great deal of attention. Practically every municipality or industry which has a waste disposal problem must eventually add equipment which will aid in the reduction of stream and lake pollution.

In order to have a better understanding of the entire sewage and industrial waste disposal problem it is necessary to know something of the agitation which is going on throughout the country on this subject. According to Dr. Henry B. Ward, the streams of this country are on their way toward being reduced to the level of open sewers. Dr. Ward is a national director of the Izaak Walton League, head of the Department of Biology at the University of Illinois and Secretary of the International Society for Advancement of Science. In an address, recently delivered in Chicago, he stated that 85 per cent of the cities in the United States were pouring untreated sewage into streams and that 95 per cent of the streams in the country are polluted, some to the extent that the health of the cities which they supply has been placed in serious danger. The Izaak Walton League has started a nation wide movement with so strong an appeal to every normal human instinct that it must be productive of hearty support and certain of success. The only conclusion is that within the near future 85 per cent of the cities in this country will be building or rebuilding sewage treatment plants. This does not take into consideration the additional construction that will be required as a result of the steadily growing population of our cities and towns.

Factory Wastes Do Harm

The construction of plants for sewage treatment will not be confined by any means to municipalities. Many industrial plants are guilty of stream pollution, just as many plants which originally located where they could obtain an abundant supply of fresh water are the victims of it. Dr. Walter Koelz, of the U. S. Bureau of Fisheries, in discussing the various reasons why food fish are becoming scarcer every year in the Great Lakes says "In later years the pollution of rivers and bays by modern industrial plants has made barren some of the most productive fishing grounds and the continuation of the evil is not only preventing the recovery of these grounds, but is spreading its effects." Factory wastes smother the bottoms of rivers and lakes if they do nothing worse, thereby preventing the growth of the plants on which fish feed. Organic wastes such as tannery waste and the washings from pulp and paper mills, creameries and canning plants, are likely to produce decomposition products that will have an actively poisonous effect.

The census of each decade is showing a larger proportion of our population as urban, so with the continued growth of our cities this water pollution by sewage will continue to increase until sewage treatment is resorted to on a large scale. It is bound to come as surely as people value good health and sanitary living conditions. The benefits it will bring will offset the large expenditures that it will require.

Types of Sewage Plants

The motor and pumping equipment required in a sewage disposal plant varies considerably depending on the system of disposal which is used. For purposes of general study of this field, sewage disposal systems may be divided into two main classes as follows:

I. Combined Sewage System (Storm water and sanitary sewage).

1. Lift station in system to reduce installation costs.
2. Pump station at end of line.
   a. Discharge into stream or lake.
   b. Discharge into treatment plant.

II. Separate system.

1. Storm water pump and lift stations.
2. Sanitary sewage systems.
   a. Lift in system.
   b. Pumps at treatment plant.
      1. Before Imhoff or aeration tanks.
      2. After Imhoff tanks—Centrifugal pumps.
      3. Sludge pumping—Plunger, air lift, centrifugal or diaphragm pumps.

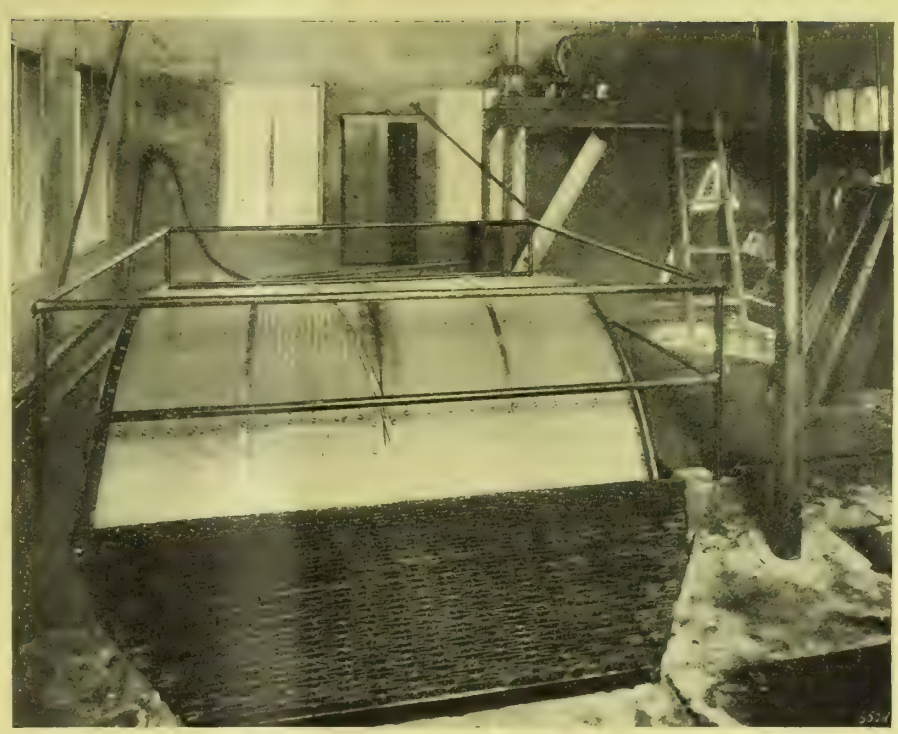
In either the combined or separate systems the first problem is to bring the storm water or the sewage or the combination of both, to the point of discharge or to the treatment plant. The most practical way has been found to be diversion of the discharge from the old outfalls of the sewers in an extensive district into an intercepting sewer built to flow as directly as possible to the works, which often are at the edge of the town. In Chicago some of these interceptors are over twelve miles long and up to 20 feet in diameter. Interceptors start at a considerable depth, and of course are much deeper when they reach the treatment plant, where pumping is required against heads up to 50 feet.

Use of Trash Pumps

Sewage contains quite a variety of solids that would frequently choke ordinary centrifugal pumps and cause many shutdowns. Installation and maintenance of even coarse screens at deep suction intakes is inexpedient be-

cause it is too expensive and troublesome. The practical solution is by the use of trash pumps.

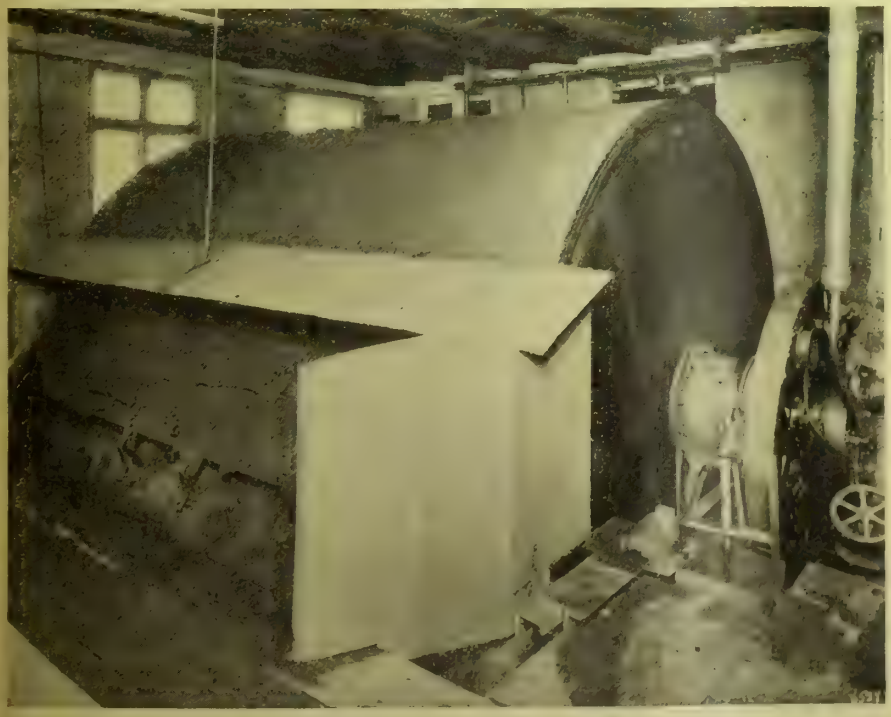
Aside from pumping at the treatment works, it is sometimes desirable to introduce intermediate pumping stations commonly called "lift" and "re-lift" stations in very long interceptors to avoid excessive construction cost for the latter because of the great depth otherwise required. Trash pumps should be used here and in all cases where raw sewage is pumped. In the Chicago district there are five intermediate pumping stations located chiefly at junctions of several interceptors. Where a separate system is used for the storm water, screw or centrifugal pumps are used for this service. Where the discharge head is comparatively low (15 to 20 ft.) the screw pump will handle storm water at the lowest pumping cost. The most outstanding example of such a system is that at New Orleans where the level of the major portion of the city is below the level of the Mississippi River and Lake Pontchartrain.



A VIEW IN THE SCREEN HOUSE OF THE PASADENA (CALIF.), SEWAGE DISPOSAL PLANT. THE DORR FINE SCREEN IS SHOWN IN THE FOREGROUND, TOGETHER WITH THE AUXILIARY EQUIPMENT AND DRIVING MECHANISM.

Combined System Predominates

Although there is an increasing tendency to separate sanitary sewage from storm water, a majority of cities have only the combined system. In this case the problem of handling the combined sewage and storm water is practically the same as in the separate sanitary system. The combined system does change the layout of the treatment plant since it becomes necessary to arrange to take care of the peaks caused by heavy rainfalls. A storm water overflow is usually provided and so arranged that a maximum flow of about six times the dry weather flow is handled by the treatment plant and the excess overflows directly into the stream or in some cases to a storm water basin. In the exceptional case where the storm flow is more than six times the dry weather flow, the dilution is considered sufficiently great to permit the excess to flow directly into the stream or lake.



THE OLIVER FILTER, AS SHOWN ABOVE, IS USED WIDELY FOR DE-WATERING THE SLUDGE. THIS SLUDGE IS LATER REDUCED TO A CAKE, CONTAINING APPROXIMATELY 8 PER CENT WATER, FOR USE AS COMMERCIAL FERTILIZER.

Screening Plants

One of the simplest systems of sewage handling is that represented by the installation now being made by the City of St. Petersburg, Florida. This plant is completely equipped with Fairbanks-Morse Wood trash pumps and motors, and shows what can be accomplished in pumping raw sewage up to the screen level instead of attempting to put the screens low enough for gravity flow.

In this type of plant a coarse screen, such as a Brunot, takes out the rags and trash, and then the sewage passes through a fine revolving screen, such as the Tark or Dorr, which removes as much of the solids as is possible. The clear liquid is then chlorinated to reduce the bacterial content and is discharged.

With the use of trash pumps it is possible to install this type of plant at a comparatively low cost and it will undoubtedly be one of the most popular types in localities where complete secondary purification is not required.

For over forty years there has been a slow development of sewage treatment succeeded by rapid progress during the last fifteen years. All early plants were experimental, and much experimentation is still carried on. Many processes have been tried out and discarded. Two have survived in this country because they have been found most effective and economical under common but somewhat different conditions. A

condensed outline of these processes will be given.

The Sedimentation Process

The first of these is the sedimentation or Imhoff tank process. In this the sewage is screened for removal of coarse solids, and then passed into two-story tanks of the Imhoff type, in which it remains about three hours while most of the solids pass into the lower or sludge compartment. The partly clarified liquid from the upper compartment is usually treated further, most commonly by what are called "trickling filters." These generally consist of spray nozzles by means of which this liquid is intermittently sprayed over a filter bed usually made of loose crushed stone or gravel 5 to 8 feet deep. After a minute or so the spraying is stopped to permit the liquid to trickle slowly over the stone, on the surface of which it is acted on by a film of bacteria in the presence of air, the combined action of which is to cause the remaining solids to adhere and then to become oxidized, thus clarifying the filtrate to within 15 or more per cent of full purity. It is then discharged into the river.

In the lower compartment of the tanks the sludge is held and acted on by another kind of bacteria that slowly disintegrate or "digest" it with liberation of gas. The sludge capacity is large so that a winter's accumulation of it may be retained in the tank until warmer weather permits its withdrawal for drying. Removal from the tank is easily effected because the sludge is porous and full of gas. The sludge is commonly spread over sand beds and allowed to dry in the open air.

The pumping problem in the Imhoff tank type of plant depends on the layout. In some cases the raw sewage flows through the coarse screens to the Imhoff tanks by gravity. Its use makes it possible to pump the raw sewage before screening and permits placing the screens at ground level with gravity flow to the Imhoff tanks.

Centrifugal pumps are used to pump the liquid from the top compartment of the Imhoff tanks to the dosing tanks. The operation of the Imhoff tanks must be continuous and the operation of the trickling filters must be intermittent, hence the use of what is termed the dosing tank. When the dosing tank fills to certain level it is discharged to the trickling filter nozzles by a syphon action.

The sludge which collects and is digested in the lower compartment of the Imhoff tank is sometimes discharged by gravity. In case the sludge drying beds are near the tanks it is generally necessary to lift the sludge to the drying beds. Various methods of sludge pumping are used, such as plunger pumps, centrifugal pumps, air lift pumps, compressed air chambers and diaphragm pumps.

The important thing in pumping sludge from the Imhoff tanks seems to be the retention of the gases of the decomposition. One disadvantage of the centrifugal pump is the violence of agitation.

Activated Sludge Process

One of the newer developments in sewage disposal plants is the use of the activated sludge process. The accompanying photographs of the Pasadena, California, sewage treatment plant, which is a fine example of this type of treatment, show very clearly the type of equipment which is used. In this process the sewage is usually first screened to remove coarse solids and often passed at reduced velocity through grit chambers to deposit sand and heavy inorganic material. It then flows through a series of aeration tanks where air is bubbled through it for a period of four to six or more hours, depending on the character of the sewage. The air agitates and oxidizes the sewage and causes its solid constituents to gather into flakes that readily settle as sludge after the mixture is allowed to flow slowly across settling tanks. The overflow from these tanks is discharged into the river. It is the effluent of the plant. Depending on the completeness of the aeration process, it has been freed of 80 to 98 per cent of the solid sewage it originally contained.

From the bottom of the settling tanks the sludge is withdrawn by airlift pumps, and 90 per cent of it is returned to the aeration tanks, where it is mixed with the incoming sewage. During aeration the oxygen of the air has made the bacteria very active, so that this now "activated sludge" on reentering the sewage greatly stimulates the biological and chemical changes taking place. In fact, aeration without re-use of the activated sludge would require several days to effect the same degree of purification that the aid of this sludge usually accomplishes in six hours or less.

Ten per cent of the sludge taken from the settling tanks is treated as excess sludge. It contains 98 to 99.5 per cent of water. Dewatering of this sludge has been difficult. It is usually effected in two stages: first, pressure or vacuum filtration to reduce the water to about 80 per cent; second, drying by heat in rotary cylindrical driers, which gives an easily handled product containing only 10 per cent water. After crushing it is suitable for shipment in bulk or bagged as a commercial fertilizer or fertilizer ingredient rich in nitrogen and commanding a market price of $15 to $25 a ton.

Pasadena System

At the Pasadena plant the treatment scheme has been modified somewhat and is carried out in the following steps. (1) Raw sewage is passed through bar screens to remove rags and large objects; (2) sewage is next passed through fine screens for preliminary treatment; (3) screened sewage is then mixed with returned activated sludge, with or without re-aeration, so that the volume of sludge in the mixture is about 20 per cent at a 30-minute settling period; (4) the mixture of screened sewage and sludge is aerated for a 4 to 6-hour period by compressed air, at the ratio of about 1.5 to 2.0 cu. ft. of free air per gallon of sewage; (5) aerated mixture of sewage and sludge is allowed to settle in clarifiers; (6) clarified sewage is finally chlorinated to remove objectionable bacteria, and is discharged into the Rio Hondo in its final form; (8) excess sludge is re-aerated, treated with alum, and filtered through Oliver filters where the water content of the sludge is reduced and the sludge converted from liquid to cake form; (9) the filter cake, 85 per cent water, is reduced to a fertilizer having 8 per cent water.

The activated sludge process is used in several other large American cities, including Chicago, Milwaukee, Indianapolis and Houston, and also in about two dozen smaller American and Canadian communities and as many in Europe. The sludge it produces can be used like other commercial fertilizers and its sale offsets part of the treatment costs. The plant does not need as high investment nor as much land as the sedimentation process, and, since it is quite free from odors, it may be located with less restriction.

Considerable more power and machinery are required for this type of plant. Economical power supply is desirable. Large plants cover considerable area; power being required at widely scattered places, electric motor drive is found most advantageous. Even small plants generally use alternating-current motor drive. If power cannot be obtained cheaply from a public utility it may be generated on the ground by one or more Diesel engine driven alternators. The Calumet treating plant in Chicago has a standby Diesel power plant of four engine alternator units.

Pumping Raw Sewage

The pumping of the raw sewage is quite similar to the pumping problem of the sedimentation system. Here also the raw sewage can be pumped up to

(*Continued on Page 57*)

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STORAGE & DISTRIBUTION

Money Invested in Pipe Line Systems Makes Careful Planning Imperative

By D. D. GROSS

*Office Engineer, Denver Municipal Water Co., Denver, Colorado**

PROBABLY the least interesting subject for discussion of any part of a water plant is the distribution system. Yet, information compiled by Metcalf, Kuichling and Hawley indicates that from 39 to 72 per cent of the money invested in a water plant is expended for its distribution system.

If, then, approximately half of the funds are invested in this one item, we should give the subject considerable thought.

The distribution system consists of the net-work of distribution mains and fire hydrants, valves, and other accessories, which receives the water conveyed to it by the supply mains or conduits and delivers it over the area to be served in accordance with the needs of the community.

It must be capable of supplying water for ordinary consumption over the whole area served at a relatively uniform rate. But it must also be able to supply the concentrated load at any point in the area necessary for the extinction of fire.

Contour Map Necessary

Before any intelligent design for a new system, or even an extension, additions, or reinforcement to an old system can be made, certain information is necessary.

In an addition to an inspection of the ground, this information is best given by a map, preferably a contour map, or in lieu of the contours, the relative elevation of important points should be known. The amount of water that will be required should also be known and may be determined from the number of consumers, the nature and amounts of their demands, and the nature of the fire protection needed.

As most water mains are installed to serve for many years to come, all information that will assist the engineer in forming the estimates as to the amount and nature of the future demands should be obtained.

Use of Office Records

In improving a water system, and most of the engineer's work will consist in making improvements to systems already in use, tests of the present system should be made. As will be outlined later on, record of pressure conditions should be kept as part of the office records.

When an extension is being planned, these records should be consulted and supplemented by necessary additional field tests. These should include static and residual pressures, and flow tests as described later on. They enable the engineer to determine the present conditions of the system and are necessary in planning the improvement.

In cities having zoning laws, these should be of assistance to the waterworks engineer in laying out or improving the distribution system. From the zoning map, he may learn the kind and use of the buildings that will be permitted in the future in any part of the city.

If the Fire Underwriters have made any recommendations affecting the work in hand, the engineer should familiarize himself with them. He should bear in mind that the total fire flow that should be available in an average city is best, but only approximately, computed by the National Board of Underwriters' formula:

$$G=1{,}020\sqrt{P}\ (1-0.01\sqrt{P})$$

Where G equals gallons per minute, and P equals population in thousands.

What the Formula Shows

From the above formula, we find that the average city with a population of 1000, the required fire flow is 1000 gallons per minute; for a population of 4000, 2000 gallons per minute; 10,000 population 3000 gallons per minute, and so on until for a population of 200,000 the requirements are 12,000 gallons per minute; over 200,000 population, 12,000 gallons per minute with 2000 to 8000 gallons additional for a second fire.

In order to secure a high rating from the Fire Underwriters and a corresponding low rate of fire insurance, the "Standard Schedule for Grading Cities and Towns of the United States with Reference to Their Fire Defense and Physical Conditions," adopted by the National Board of Fire Underwriters, December 14, 1916, should be followed as finances will permit.

Line Pressure Control Design

Perhaps the first point to decide upon in proceeding with the design, is the pressure.

Perhaps this point is already decided and it is known that the supply will be received at a certain pressure. In that case it is necessary to design the system to meet the conditions. The system should be designed not only to distribute the water, but to maintain an adequate service pressure even when the draft becomes a maximum for which the service is designed.

Pressure may vary in different systems, or at different points in the same system and still give satisfaction; but a wide variation at the same point, either at different hours of the day, or at different seasons of the year, is sure to cause numerous complaints.

A repeated falling off in pressure is sure to displease the consumer and cause more complaints than a uniformly low pressure.

Desirable Pressures

The actual pressure at the service connection or fire hydrant may vary from 20 to 130 pounds and give satisfactory service under certain conditions. If the service is only 20 pounds, the buildings served must be low, and the fire engines must be provided to give fire service, while 130 pounds pressure is probably more than most plumbing will stand unless it was installed for that high a pressure. The most desirable pressure for a residential district is from 40 to 75 pounds; but if the district is large, the topograph will probably make it out of the question to stay inside that limit and pressure will probably vary from 30 to 100 pounds. A desirable static pressure for a business district is 60 to 75 pounds, but it is better to exceed 75 pounds than to fall below 60 pounds.

Topography frequently makes it impracticable to supply the entire city from one general system. It then becomes necessary to divide the city into zones, depending upon the controlling elevations. In quite common cases, the lower zone includes the principal area of the city. Booster pumping stations, drawing from the distribution reservoirs raise the water to supply the higher outlying districts.

The average daily consumption in cities varies from 40 to 250 gallons per

*Paper given before the Rocky Mountain Section of the A. W. W. A. at Denver, February, 1927.

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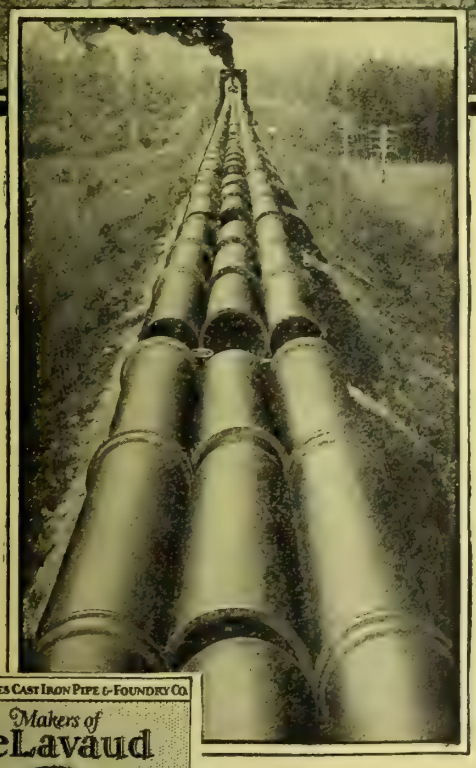

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capita. The quantity for the case in question should be estimated, taking into consideration the nature of the industrial and domestic needs, including lawn sprinkling or, irrigation, and adding an allowance for leakage from the city mains and service pipes. To this quantity should be added the amount required for fire protection.

Segregation of System

The Manual of Water Works Practice, published by the American Water Works Association, considers that, "Three classes of distribution mains appear in the make-up of a large system:

"1. Primary feeders, constituting the skeleton of large pipes with relatively wide spacing, convey large quantities of water to various points in the system for local distribution through the smaller mains.

"2. Secondary feeders, forming the network of pipes of intermediate size which reinforce the distributor grid within the panels of the primary feeder systems, and aid in the concentration of the required fire flow at any point.

"3. Distributors, consisting of the grid-iron arrangement of small mains serving the individual hydrants and blocks of consummers."

The writer has found it advisable, in laying out the first of the above classes, namely, the "Primary Feeders," to follow as closely as possible to the high contour line of the district to be served. This plan makes for more uniform distribution as a general course of the flow through the smaller mains is down hill. But the greater pressure and shock otherwise obtained at the lower parts of the district, when a large quantity of water is being used, is to a considerable degree overcome by the friction of the pipes. In short, we have gravity and friction working in opposite directions and hence the pressure is more nearly uniform between the high and low points of the district while the mains are performing the heaviest service.

Secondary Feeders

The second class, called the "Secondary Feeders" are best spaced at intervals in both directions. A plan found satisfactory in the residential section is to use 12-inch mains and space them one-half mile apart in each direction.

The third class, called "Distributors" should not be less than 6-inch mains. If laid in connection with the above mentioned 12-inch grid, they may be laid of 6-inch pipe on long side of the block and will give good service; but in order not to be severely penalized by the Fire Underwriters when the district becomes closely built up, it will be necessary to install 8-inch or larger cross connections.

In the business, or high value districts, the minimum size of mains should not be less than 8-inch with frequent cross connections and 12-inch or larger mains on the principal streets.

The writer has found the "Hazen-Williams" formula satisfactory in computing the capacity of water mains, and the "Williams and Hazen Hydraulic Tables" a means of obtaining results with much saving in time and labor.

Valves and Fire Hydrants

Valves should be systematically placed with reference to street line to facilitate their location. They should be installed on all branches from feeder mains. At street intersections where the grid iron mains are connected, it is good practice to have not less than three valves. If this rule is followed at each intersection, it is possible to shut out any block of pipe by the closing of not more than from two to four valves. If this rule cannot be followed, it is important at least to space valves so that it is not necessary to close more than five or six in order to gate off any given section of pipe. Valves of the double disc type are in common use.

Fire hydrants should be set at each street intersection. If the blocks are long in the residential and business sections, or high value district, they should be set at more frequent intervals in order to meet the Fire Underwriters' requirements. According to the Fire Underwriters' standards, "hydrants shall be able to deliver 600 gallons per minute, with a loss of not more than 2½ pounds in the hydrant and a total loss of not more than 5 pounds between the street main and the outlet; they shall have not less than two 2½-inch outlets and also a large suction connection where engine service is necessary." "They shall be of such design that when the hydrant barrel is broken off the hydrant shall remain closed." "Street connections shall be not less than 6 inches in diameter and shall be gated."

Storage reservoirs or tanks connected to the distributing system are a great advantage. They not only make for economic construction making it possible in some cases to reduce size of mains or operate the plant at less cost, but, in cases of accident, provide a supply for emergency use. If the water supply is filtered or obtained from ground water, the reservoir tank should be covered to shut out the sun light, thus preventing vegetable growth in the water.

Dead ends are the bane of a water works man's life. They should be avoided wherever possible and eliminated at the first opportunity. Where they cannot be avoided, as is often the case in the outlying districts, means should be provided for flushing them. It is a good plan to set a fire hydrant at the end of the main even though the supply of water may be small for fire protection.

For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

Records in the form of maps should be kept to show the location of all specials, valves, and hydrants. It is preferable that mains should be laid a certain distance from the property line and on a given side of the street, and that the line should actually be laid out by a surveying party. It is also good practice for the surveying party to set grade stakes for all the larger mains. Mains that wander about from side to side of the street, are the cause of a great deal of distress when it becomes necessary to lay additional mains or other underground structures in the street.

At prominent points in the system, continuous records of pressure should be kept by recording gauges. At frequent intervals, if the city is growing rapidly, tests should be made at the fire hydrants in all parts of the system. These should consist of taking the static pressure at the fire hydrants; the residual pressure upon the hydrant with one or more neighboring hydrants open; the discharge from the open hydrant measured with a Pitot tube or flow gauge. The results of these tests together with the record of the date and time of day that they were made, should be kept as a matter of record. For this purpose a card system is best.

When installing primary feeds, it is a good plan to make connections and construct vaults to facilitate pitometer tests. By this means, the use of water among the principal districts of the city may be learned.

In case the mains are subject to electrolytic corrosion due to stray electric currents, an electrolysis survey should be made to determine the nature of the damage already done and the measures that might be best employed to reduce future corrosion.

Buys Bisbee-Naco Water Co.

The Peoples Arizona Gas and Electric Corporation, a subsidiary of the W. B. Foshay Company of Minneapolis, has announced the purchase of the Bisbee-Naco Water Company, of Bisbee, Arizona. The sale price was not stated, but it is reported that approximately $450,000 was involved in the purchase. The W. B. Foshay Company is acquiring widespread interests, having taken over since the beginning of the year properties in Texas, Pennsylvania, Kansas, Wisconsin, and Vermont.

Shafter Wants More Water

Residents of Shafter, Kern County, California, are circulating a petition asking that a public utility district be established in order to afford a water supply for domestic and fire purposes. The present system is said to be inadequate.

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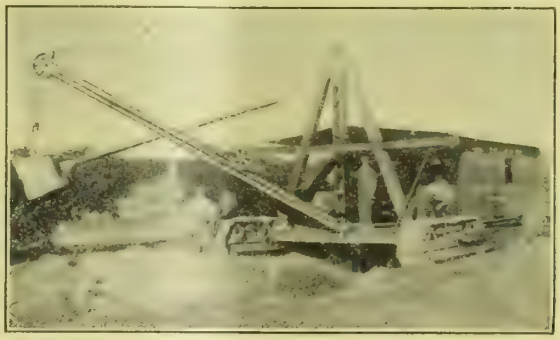
BAY CITY Land Dredges span the ditch, can dig any desired slope, and dump waste on both banks. BAY CITIES leave clean, wide berms, and can work up or down streams. One trip over the ditch is enough. The Shovel Type Dipper handles hard material in which other types of buckets cannot make a good showing.



At left—One yard BAY CITY Dredge digging and cleaning ditches in Florida Citrus Groves.

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FOR SMALLER DITCHES — OR PIPE LINE TRENCHES

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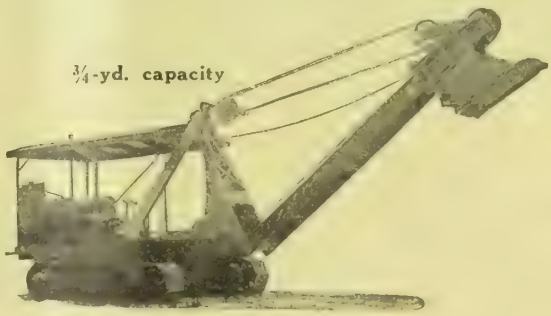

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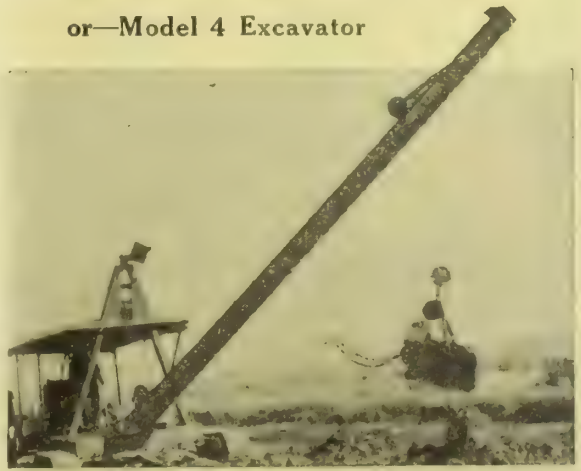

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WATER PURIFICATION

The Use of Sodium Aluminate as a Coagulant for Water Purification

Difficulties Encountered in Using Filter Alum Somewhat Lessened by Sodium Aluminate Properly Introduced into the Filtration Process

By J. B. BARNITT and E. H. HAUX

*Research Bureau, Aluminum Company of America**

FILTER alum, whether alone or in conjunction with soda ash and lime, has been used to coagulate and eliminate the impurities of water ever since the early days, when it was first considered necessary to purify water at all and particularly to prepare it for use in towns and cities. Like many other customs, the practice of using filter alum for this purpose has been the practice for such a long time that it has become the acknowledged procedure and, when the coagulation and purification of water is considered, it is usually with the fixed idea that filter alum, either alone or in conjunction with an alkali, provides the only practical and economical means of accomplishing the desired result. This practice has been justified until recently, because no one has been able to discover a product or supplant it, either in efficiency or cost, or both.

It is presumed that the filtration engineer has learned, by experience, the shortcomings of filter alum as a coagulant. He knows that when used alone sulphate hardness and carbon dioxide are produced. In order to eliminate these undesirable by-products, it is necessary to treat the water with an alkali, which is both an additional operation and expense. He knows that the conditions under which coagulation is effected are at times difficult to control, particularly when temperature is a factor; that "after reactions" frequently produce basic aluminum sulphates, reducing the coagulating efficiency and leaving undesirable products in the purified water. He also knows that alum solutions, particularly when used in wet feed equipment, cause corrosion. When he buys filter alum he is paying for a large percentage of water; freight must be paid on this water and additional storage space must be provided.

Sodium aluminate has recently been developed in response to the demand for a coagulant which will tend to eliminate the difficulties incident to the use of filter alum. However, before going into the subject of coagulation with sodium aluminate, it may be well to give a brief outline of its properties. It is well known that aluminum hydroxide is an amphoteric compound; that is, in the presence of acids it reacts as a weak base, and, in the presence of bases, reacts as a weak acid. For this reason it is possible to prepare salts such as aluminum sulphate, in which the aluminum is present as the base, and also compounds such as sodium aluminate, in which the aluminum is present as the acid radical.

Sodium aluminate has never been crystallized from aqueous solutions. However under varying conditions, it is possible to prepare a mixture approximating the formulas $Na_2O.Al_2O_3$, $2Na_2O.Al_2O_3$ and $3Na_2O.Al_2O_3$. These mixtures, in contact with water, yield solutions of aluminum hydroxide in caustic soda; their stability is directly proportional to the amount of caustic soda present and the mixture $Na_2O.Al_2O_3$ is the least stable. In other words a solution of the compound $Na_2O.Al_2O_3$ being unstable, a portion of the aluminum hydroxide will continue to precipitate until a caustic concentration is reached which will retain the remaining aluminum hydroxide in solution. Obviously, a sodium aluminate corresponding to the formula $Na_2O.Al_2O_3$ is the form best suited to water purification, since it has the advantage of precipitating the hydroxide (floc) immediately upon contact with water. It is this form of aluminate which is referred to in the remainder of this discussion.

Properties of Sodium Aluminate

Sodium aluminate has numerous useful and unique properties. Its use particularly tends to minimize, if not entirely eliminate, the undesirable features of filter alum, when used either alone or in conjunction with it. Experience so far has shown that sodium aluminate treatment effects an appreciable saving in chemical costs when compared with the lime alum treatment. Its alkaline nature is obviously of decided advantage, as no sulphate is introduced by it during decomposition to form floc. Another decided advantage is its large alumina content, which results in a high precipitation and coagulation efficiency. Sodium aluminate is readily soluble in cold water and when added to it, under proper conditions of acidity and alkalinity, will precipitate its alumina in the form of a flocculent hydroxide. In waters which contain free carbonic acid or bicarbonates of calcium or magnesium, sodium aluminate may be used alone or in conjunction with enough filter alum to properly adjust the hydrogen ion concentration so as to produce the maximum floc. If alkaline waters are to be treated it may be necessary to use sodium aluminate in conjunction with filter alum. The high alkalinity character of sodium aluminate, when used alone, at times interferes with the establishing of hydrogen ion concentration consistent with the maximum precipitation of floc. The mechanism of the reactions involved and the advantages gained are covered in the following description of sodium aluminate water treatment.

Chemical Action in Water Treatment

Inasmuch as the purification of water supplies plays an ever increasing part in the protection of the public health, and in providing water of satisfactory quality for commercial use, it may be well to first briefly discuss the old method of purification. The primary functions of the chemical treatment of water are the elimination of turbidity and temporary hardness which are necessary for the production of a potable water. For this purpose alum is usually employed in conjunction with lime, soda ash, or the natural alkalinity of the water itself.

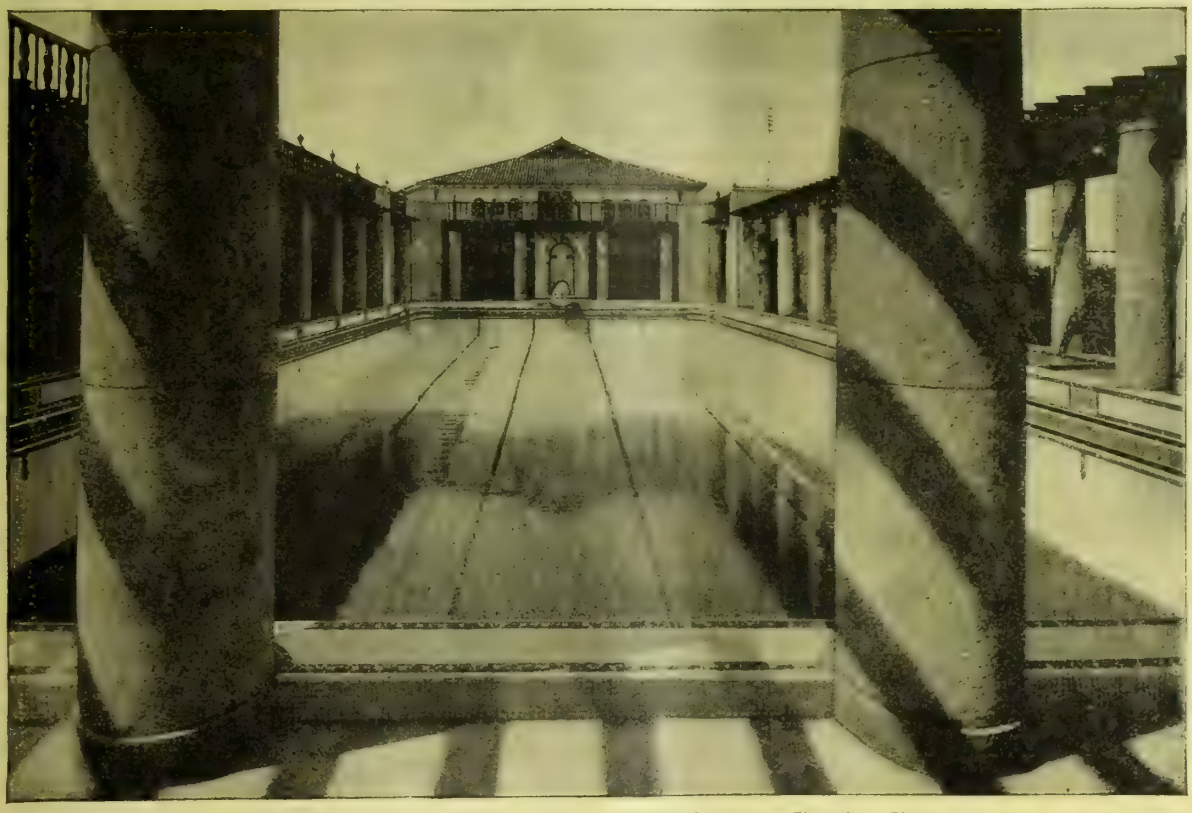
The effective coagulating material formed is aluminum hydroxide $Al(OH)_3$, which is produced as a flocculent precipitate.

The purified water in most cases will contain two objectionable constituents, namely: free carbon dioxide and permanent hardness. The effects produced by these constituents can be measurably minimized by the use of an alkaline material such as sodium aluminate.

Here the effective coagulating material is aluminum hydroxide. It should be noted at this point that the precipitation of the carbonates of calcium and magnesium is incident to the formation of sodium carbonate as a by-product.

As has been previously stated, sodium

*A paper presented at the Annual Convention of the Southeastern Water and Light Association.



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aluminate, $Na_2O.Al_2O_3$, in solution is an unstable product and will hydrolize and precipitate a portion of its aluminum hydroxide until a definite alkalinity is reached. It is, therefore, merely necessary to disturb the solution equilibrium in order to completely precipitate the aluminum hydroxide. This can be accomplished by the acidity of the water, as determined by the presence of carbon dioxide or bicarbonates. If, however, the acidity is not great enough, the use of additional acid reagent is recommended, such as filter alum. In this type of treatment the aluminum hydroxide from both sodium aluminate and the filter alum is precipitated simultaneously. Sodium sulphate is produced during the reaction and is not objectionable in the amounts formed.

The sodium bicarbonates formed as a by-product tend to increase the softness of the water, reacting with the calcium and magnesium sulphates which are present, and precipitating their respective carbonates.

Although the softening which results from this sodium aluminate may not be appreciable because of the small quantities used in treatment, it should be remembered that the permanent hardness is increased when the lime is used. The advantage gained by the softening action of the sodium aluminate is further increased by the decrease in hardness, due to the elimination of the lime treatment and should prove of practical value to the filtration engineer.

Use of Sodium Aluminate

When sodium aluminate is employed in water purification, experience has shown that the most satisfactory results are obtained by the introduction of sodium aluminate first, in case it is found that a small quantity of alum must be added to produce optimum coagulating conditions. The addition of the proper quantity of alum should then be made, in order to complete the precipitation, of the aluminum hydroxide. The ratio of sodium aluminate to alum should in all cases be maintained at such a point as to keep the quantity of alum at the minimum and the quantity of sodium aluminate at a maximum, and still produce a good floc.

It is well known that insufficient alkalinity, natural or artificial, in reactions with aluminum sulphate will cause the formation of various basic sulphates, as for example, $Al_2(SO_4)_2(OH)_2$, $Al_2(SO_4)_3$, $Al_2(OH)_6$ and $Al_2SO_4(OH)_4$. Some of these are soluble, so that no precipitation will occur, thus accounting for the difficulties sometimes met with in obtaining proper precipitation, especially in winter, when the reactions are slow, and the hydroxide formed combines with the aluminum sulphate still in solution.

Weak Solution of Sodium Aluminate

In wet-feed apparatus, frequent changing of the pipe lines and fittings carrying the alum solution are necessary because of corrosion. It has been established that a one or two per cent solution of alum has little or no effect upon iron. The use of weak solutions is made possible by the extremely small dosages of alum necessary to produce the desired floc in conjunction with sodium aluminate.

This discussion of merits of sodium aluminate as a water coagulant would be of little value from the commercial standpoint if the material were too expensive to compete with filter alum. Fortunately, this is not the case, since a commercial form of sodium aluminate can be produced from aluminous materials in such a way that the manufacturing costs will permit favorable comparison with filter alum. The method of manufacture is such that small amounts of sodium silicate and sodium ferrate are also present in commercial sodium aluminate. The major active constituent, however, is sodium aluminate, its activity in floc formation being augmented to a certain degree by both the sodium silicate and the sodium ferrate. In contact with water, sodium ferrate will immediately hydrolyze and add to the alumina floc its portion of ferric hydrate. Sodium silicate will act in somewhat the same manner as sodium aluminate, precipitating its hydrated silica in conjunction with the hydrated alumina from the sodium aluminate.

Quantitatively, this is more or less of an indeterminable value, but it is obvious that it is additive to the coagulative effect produced by the alumina itself. The remainder of the constituents in sodium aluminate consist of the unacted-upon silica, alumina, and iron, which occur in the raw material used to manufacture it. This insoluble content will vary from about 10 per cent to 15 per cent in the commercial grade of sodium aluminate.

This finely divided insoluble material affords nuclei for the formation of floc, thereby directly aiding in the coagulation of impurities in the raw water, particularly in the instance of clear water. Commercial sodium aluminate will contain about 50 per cent water soluble Al_2O_3, and 35 per cent soda as Na_2O. In making a comparison between the sodium aluminate and alum treatments, it is well to remember that sodium aluminate has three times the alumina content of filter alum. Furthermore, the user receives with each pound of alumina in sodium aluminate about .7 of a pound of soda as NaO.

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The following advantages can be obtained by the use of sodium aluminate in the coagulation and purification of water supplies:

ADVANTAGES OF SODIUM ALUMINATE

(1) The production of a rapid settling floc of high enveloping efficiency.

(2) Rapid completion of reaction regardless of temperature.

(3) Reduction of temporary bicarbonate and permanent hardness in the treated water.

(4) Elimination of the separate use of lime and soda ash.

(5) No after reaction.

(6) Tends to produce a treated water, less corrosive to the mains because of the elimination of carbon dioxide.

(7) Elimination of the corrosion of the feed pipes due to alum solutions when wet feed apparatus is used.

(8) A product of approximately three times the soluble alumina content of filter alum.

(9) A product requiring one-third the storage space of filter alum per unit of available coagulating material.

(10) A freight saving since it contains three times the alumina content of alum and no water.

(11) An appreciable saving in chemical costs as compared with the alum or alum-lime treatment.

Aberdeen Has New Reservoir

Aberdeen, Washington, is now using water from its new Fairview reservoir No. 2, the latest link in the city's water distribution system. The reservoir was built at a cost of approximately $130,000 and will hold, when filled to its capacity depth of 25 feet, a total of 15,000,000 gallons. This basin will more than double the city's supply of reserve water and it is thought will eliminate almost any chance of water shortage. The reservoir is said to be one of the strongest ever built on the Pacific Coast.

Twin Cities to Join Systems

The city commissions of Centralia and Chehalis are planning to connect the water systems of the two cities for mutual protection. City engineers of both cities are working to determine the costs of the project. It is desired to extend an 8-inch main which Centralia has laid as far as the Southwest Washington fair grounds to connect with the Chehalis main on National avenue.

Armona Plans Water District

Armona, Kings County, California, plans to call an election soon for the formation of a water district. It is probable that the installation of an ample water system for domestic service and fire protection will involve an outlay of between $20,000 and $25,000, but it is thought that the saving in insurance and the other advantages accruing to property owners will more than offset the slight increase in taxation.

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Current Meter Notes

The current meter problem is unsolved as long as the forces that rotate the meter are not known. The word "velocity force" may be the right answer but it is not specific enough to be acceptable.

Through the introduction of a mechanical current meter into a stream, the velocity force is transformed into a number of forces which may or may not act uniformly upon the meter rotor. In fact, it is known that some of the newly created forces oppose the original velocity force. Acting and reacting forces are freely mentioned in current meter discussions.

The presence of an unknown force seems to be demonstrated by a Price meter rotating in a stream flow of 0.1 ft. per sec. velocity. Such velocity represents a force equal to the pressure of a column of water 0.0018 inches high (if the formula V=square root of 2gh is correct and applicable). This pressure is, according to ordinary reasoning, insufficient to accomplish such work as rotating a submerged turbine of the Price meter type.

Since Price meters rotate in streams of such low velocities and since force is required to do such work, where does the force come from?

Is a similar force active at horizontal shaft meters? Apparently it is but to a lesser degree, for which reason such meters do not start rotating until velocities are developing a little more pressure.

It is evident that this unknown force is stimulating to meter action, but it must be of positive origin in order to be beneficial to meter work. If that force is a result of eddies, which are especially varying or unstable when the turbine rotates slowly, it can not improve the meter results.

Whatever this force may be, it is observed only at the very lowest velocities, its influence ceases, apparently, with increasing meter action. It is important to determine whether this unknown force, when aided by instrumental sensitiveness, is desirable or disadvantageous to current meter work.

More Sewers for Tacoma

Tacoma, Washington, is making plans for the installation of 35,899 feet of 8 to 54-inch concrete sewer mains and laterals tributary to the Pearl Street trunk. It is estimated that the cost will be $189,353.

Lays Main Across River

Mt. Vernon, Washington, has begun work on the laying of a larger main on the bed of the Skagit River to provide for the requirements of the West Side.

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New Rotary Type Water Meter Developed by the English

A rotary type meter for water measurement has been developed by the Leeds Meter Company of England for use in that country. The Leeds Rotary Meter is made for domestic as well as industrial use and it can be supplied for either horizontal or vertical service pipes varying in size from ¼-inch to 1½-inch in diameter. The instrument is sensitive to small flows and it has a large delivery capacity. All working parts are made of pure nickel.

This type of meter is also made in the larger sizes, but usually where large volumes of water are to be measured, a Helix meter is used. The Rotary meter is built in two different types, one type having a fixed internal mechanism, and the other being removable. The type having the removable internal mechanism has many advantages, one of which is that the working parts may be removed from the case and restored in a few minutes, without disconnecting the meter from the pipe line. This proves of great advantage when cleaning or re-testing.

For widely fluctuating flows a combination meter is marketed. This consists of two meters: a large meter upon the main, and a small meter upon a by-pass. These two meters are controlled by an automatic valve which diverts through the by-pass such small flows as would not be recorded on the large meter.

Colorado Springs Builds Dam

Construction of retention reservoir No. 1, the first of two units to be built by Colorado Springs for the retention of flood waters to protect the west side property, is now well under way, according to recent reports from that city. The new dam will be 500 feet long, 28 feet high, and 160 feet at the bottom, its construction being entirely of removed gravel, with the face protected by stone riprapping. It will contain about 24,000 cubic feet of earth, and will store about 11,250,000 gallons of water, according to the specifications of F. O. Ray, city engineer. If the outlet pipe were closed, the reservoir would hold all the precipitation of a three-inch rainfall on the drainage area served by the dam.

Charles M. Adams, of Bellingham, Washington, former city engineer and also former county engineer of Whatcom County, where he has been engaged in public engineering work for about ten years, has accepted a two-year contract as engineer for the installation of sewer and water systems for the city of Santo Domingo. It is estimated that the installaion will cost about $2,500,000.

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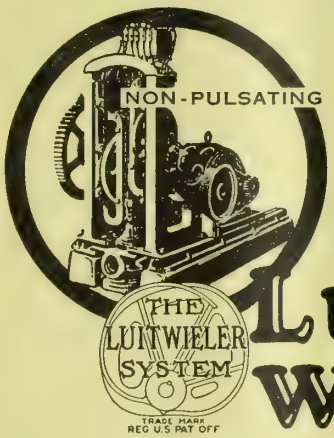

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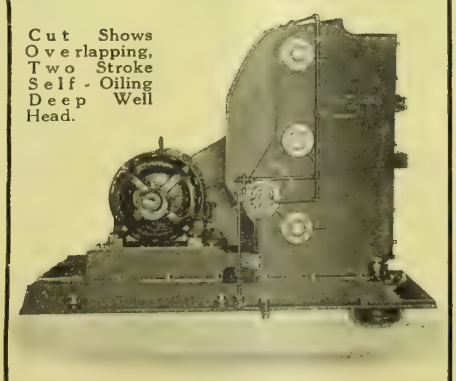
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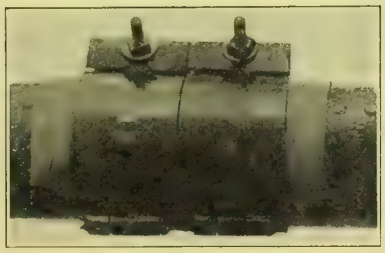

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With the California Railroad Commission

Hydraulic Division Makes Report

The year 1926 was an unusually busy one for the Hydraulic Division of the Engineering Department of the California Railroad Commission, the amount of formal matters handled reaching the high peak of the years 1920 to 1922, when a tremendous amount of work was thrown upon the Commission by the sudden and unprecedented development of the State.

The most gratifying feature in the water development of California during 1926 has been that although the greater portion of the state suffered a serious water shortage, resulting from a year of low rainfall, immediately preceded by a cycle of several years of deficient rainfall, the efforts of the Commission's Hydraulic Division have resulted in preventing any serious inconvenience to the public.

Due to an abundant rainfall during the present winter, the year 1927 is initiated under circumstances indicating a prosperous year from the standpoint of industries depending upon water supply for their existence, engineers of the Hydraulic Division report.

There has been a considerable increase in the number of new water utilities during the last year, and this year marked the beginning of a move to consolidate many of the larger domestic water systems under one management. There are now a number of investigations under way by the Hydraulic Division of the Commission to determine whether the rates in effect on certain water utilities are producing more than a fair return upon the investment.

Explains Jurisdiction of Commission

Commissioner Leon O. Whitsell in an address before the City Club of Los Angeles, in which he reviewed the work of the Railroad Commission, referred to the fact that there has been much speculation on the part of owners of wells and irrigation systems as to what acts bring them within the jurisdiction of the Railroad Commission, and as to whether or not pumping water for a neighbor to help out in a water shortage, brings a water system within the jurisdiction of the Commission. The following excerpt was quoted by Commissioner Whitsell from the Public Utilities Act for the regulation of water companies, and clearly states those cases which do not bring the owners of water within the provisions of the Act:

"That whenever the owners of a water supply, not otherwise dedicated to public use and primarily used for domestic purposes by such owners or for the irrigation of such owners' lands, shall sell or deliver the surplus of such water for domestic purposes, or for the irrigation of adjoining lands, or whenever such owners shall, in an emergency water shortage, sell or deliver water from such supply to others for a limited period not to exceed one irrigation season, or whenever such owners shall sell or deliver a portion of such water supply as a matter of accommodation to neighbors to whom no other supply of water for domestic or irrigation purposes is equally available, then such owners shall not be subject to the jurisdiction, control and regulation of the Railroad Commission of the State of California."

Combine Has New Finance Plans

California Water Service Company has filed an amended application with the California Railroad Commission for authority to issue $6,000,000 face value of five per cent first mortgage gold bonds Series "A," to net $5,940,000; $2,150,000 face value of preferred stock to net $1,870,500; and $2,149,300 face value of common stock, to net $1,611,975; or a total of $9,422,475.

Applicant proposes to use the proceeds of the aforesaid bonds and stock for the purchase of capital stock of Chico Water Supply Company, Port Costa Water Company, Fresno City Water Corporation, Visalia City Water Company, Electric Water Company of Bakersfield, and Bakersfield Water Works, Hermosa-Redondo Water Company; the properties and business of Chico-Vecino Water Company (owned by C. B. Jackson); the properties and business of W. E. White Water Company of Chico (owned by C. B. Jackson); water plants of Pacific Gas and Electric Company in Stockton, Oroville, Redding, Willows, Dixon and Livermore; and for the acquisition and consolidation of all properties involved, together with engineering and other incidental expenses, and for the discharge of outstanding bonds against the various properties.

Amends Water Purchase Agreement

Authority has been granted by the California Railroad Commission to Pacific Gas and Electric Company to transfer to C. B. Jackson, or his nominee, the water plants owned and operated by the former in the cities of Stockton, Oroville, Redding, Willows, Livermore and Dixon, for the sum of $2,455,000, as of July 31, 1926, subject to the condition that the purchase agreement be amended to eliminate all provisions therein that give Pacific Gas and Electric Company free use of and to any property that is being sold, or give the seller the right to water without charge. It is held that whatever water is furnished by Jackson or his assigns to Pacific Gas and Electric Company should be furnished at rates approved by the Commission, and also that Pacific Gas and Electric Company should pay a reasonable consideration for the use of any property which under the terms of the agreement it has agreed to sell to Jackson.

Utilities Corporation Will Issue Bonds

Imperial Utilities Corporation, operating public utility water systems at Wilmar, Los Angeles County, Niland and Calipatria, Imperial County, and San Bernardino County, has applied to the Railroad Commission for authority to issue and sell $125,000 of its Series "A" bonds, at not less than 90 per cent of face value, and use the proceeds thereof to liquidate outstanding notes and obligations and to finance additions and betterments.

Authorizes Bond Sale

Claremont Domestic Water Company has been authorized by the Calif. Railroad Commission to issue and sell, on or before June 30, 1927, at not less than face value, plus accrued interest, $10,000 of its first mortgage six per cent bonds, due March 1, 1954, and to use the proceeds to pay indebtedness and finance additions and betterments.

Will Finance Improvements

Hermosa-Redondo Water Company has been authorized by the California Railroad Commission to use $30,300 of the proceeds from the sale of bonds heretofore authorized by the Commission to finance improvements.

For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

Hermiston Irrigation District Shows Successful Record

Reservoir Stores More Than 50,000 Acre Feet of Water; Irrigation System Comprises 103 Miles of Ditches

The Hermiston Irrigation District has been one of the outstanding successes in Oregon through its history of nearly twenty years. Organized in 1906, the original project was completed in 1908. It is located in western Umatilla County, Oregon, 190 miles east of Portland and 35 miles west of Pendleton.

Water is diverted from the Umatilla River into the feed canal and conveyed to the Cold Springs reservoir, east of Hermiston. This reservoir covers more than a square mile and holds more than 50,000 acre-feet of water. So far, it has never failed to fill during the flood water season. In addition to this storage there is a supplemental water right which diverts direct from the Umatilla River and runs on an average of 25 second feet of water during the irrigating season, from April to October.

Big Concrete Job

The irrigable area of the project is now about 12,000 acres. This 12,000 acres is equipped with one of the most complete irrigation systems to be found anywhere, which consists briefly of:

One hundred and three miles of ditches, mostly concrete lined, requiring the placing of more than 48,000 cubic yards of concrete. There are 16 structures costing more than $2000 each, 19 structures costing from $500 to $2000, 67 structures costing from $100 to $500, and 1300 structures costing less than $100 each. To build the above more than 68,000 barrels of cement were used, and the uneven topography of the land made necessary the placing of 170,000 feet of pressure concrete pipe lines.

The climatic conditions of the district are very attractive. There is an average precipitation of about eight inches, and the growing season averages 175 days. The size of the farm units varies from ten to forty acres. The soil is a sandy loam and well adapted to the production of alfalfa, small fruits, vegetables, asparagus and pasture. Poultry raising is proving a profitable industry.

The project is traversed by the famous Columbia River highway and by the main line of the Oregon, Washington, Railroad & NavigationR. R., a great advantage in making more accessible a market for the products of the district.

J. A. Teagarden, of Mt. Vernon, California, has been elected director from Division 3 of the Nevada Irrigation District.

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SURVEY *of* HYDRAULIC DEVELOPMENT

As Shown by Official Records of the Month -- Local, State, and Governmental

Applications Filed

Among the more important applications for permits to appropriate water filed with the State Department of Public Works, Division of Water Rights, California, during February, 1927, were the following:

Application 5340 (Siskiyou County)—J. Wilborn Deason, care of Carl Langford, Somes Bar, Calif., for 3.00 cubic feet per second from Deason Creek tributary to Salmon River. To be diverted in Section 2, T 11 N, R 6 E, H. M. for irrigation and domestic purposes. 7.0 acres. Estimated cost $1000.

Application 5345 (Humboldt County)—David S. Ward, care of Mahan & Mahan, First Nat'l. Bank Bldg., Eureka, Calif., for 0.12 cubic foot per second from Third Slough tributary to Humboldt Bay. To be diverted in Section 25, T 5 N, R 1 W, H. M. for irrigation purposes. 55 acres. Estimated cost $2,500.

Application 5346 (Kern County)—Samuel K. Phillips and Rebecca W. Van Dyck, Inyokern, Calif., for 0.026 cubic foot per second from Indian Wells Spring. To be diverted in Section 16, T 26 S, R 38 E, M. D. M. for irrigation and domestic purposes. 5 acres. Estimated cost $750.

Application 5349 (Butte County)—Nellie F. Lively, Box 538, Eureka, Calif., for 1.50 cubic feet per second from Lat. "E" Reclamation District No. 833, tributary to Butte Creek and Sacramento River. To be diverted in Section 33, T 18 N, R 2 E, M. D. M. for irrigation purposes. 60 acres of rice.

Application 5351 (Los Angeles County)—S. H. Woodruff, 2690 North Beachwood Drive, Los Angeles, Calif., for 10.00 cubic feet per second from San Juan Creek, wells and surface flow tributary to Pacific Ocean. To be diverted in Section 14, T 8 S, R 8 W, S. B. M., Section 23, T 8 S, R 8 W, S. B. M. for irrigation and domestic purposes. 625 acres and 15,000 domestic users.

Application 5354 (Napa County)—State Board of Control, care of Division of Water Rights, Sacramento, Calif., for 41.82 cubic feet per second and 5,000 acre feet per annum from Rector Creek tributary to Conn Creek and Napa River. To be diverted in Section 20, T 7 N, R 4 W, M. D. M. for irrigation and domestic purposes. 3,346 acres. Estimated cost $555,500.

Application 5359 (Yolo County)—Frank L. Fisher, 1133 39th St., Sacramento, Calif., for 34.79 cubic feet per second from Sacramento River, tributary to Suisun Bay. To be diverted in Sections 27, 26 and 36, T 11 N, R 3 E, M. D. M., Section 11, T 10 N, R 3 E, M. D. M. for irrigation purposes. 3193 acres of rice. Estimated cost $16,000.

Application 5360—Harry Barnes for San Joaquin Water Storage District, Bank of Italy Bldg., Los Banos, Calif., for 1,000 cubic feet per second from Reservoirs of Southern California Edison Company tributary to San Joaquin River. To be diverted in Sections 19 and 25, T 13 S, R 15 E, M. D. M., Section 12, T 11 S, R 13 E, M. D. M., Sections 17 and 26, T 9 S, R 12 E, M. D. M., Section 29, T 13 S, R 16 E, M. D. M., Section 5, T 11 S, R 21 E, M. D. M. for irrigation purposes. 552,000 acres. Estimated cost $29,732,400.

Application 5364 (San Joaquin County)—Ralph Lucas and G. B. Ratto, Box 29, Clements, Calif., care of Ralph Lucas, for 5 cubic feet per second from Middle River tributary to San Joaquin River. To be diverted in Section 1, T 1 S, R 5 E, M. D. M., for agricultural purposes. 400 acres. Estimated cost $3,500.

Permits Issued

Among the more important permits to appropriate water issued by the Department of Public Works, Division of Water Rights, California, during February, 1927, were the following:

Permit 2714, Application 5016 (Sutter County) Issued to Rio Oso Fruit Company, Inc., Woodbridge, Calif., February 3, 1927, for 11.46 cubic feet per second from Bear River in Sections 8 and 9, T 13 N, R 5 E, for irrigation of $16.68 acres in Sections 7, 8, 9, 16 and 17, T 13 N, R 5 E, M. D. B. & M. Estimated cost $30,000.

Permit 2715, Application 5135 (San Bernardino County) Issued to Redlands Security Company, Redlands, Calif., February 4, 1927, for 0.003 cubic foot per second from an unnamed spring in Section 19, T 2 N, R 3 W, for domestic and irrigation of 2 acres in Section 24, T 2 N, R 4 W. Estimated cost $2750.

Permit 2716, Application 5273 (Ventura County) Issued to C. C. Copley, Pasadena, Calif., February 7, 1927, for 0.4 cubic foot per second from Tinta Creek in Section 32, T 8 N, R 24 W, for domestic use and irrigation of 120 acres in Section 28. Estimated cost $3,000.

Permit 2717, Application 4413 (Humboldt County) Issued to The Benbow Company, Garberville, Calif., February 10, 1927, for 1.27 cubic feet per second and 1054.74 acre feet per annum from East Branch and South Fork Eel River in Section 2, T 5 S, R 3 E, for irrigation of 102 acres in Section 36 and also domestic and recreational purposes. Estimated cost $20,000.

Permit 2718, Application 5287 (Butte County) Issued to Harry Howard, Chico, Calif., February 14, 1927, for 0.5 cubic foot per second from Dicus Pond, in Section 24, T 23 N, R 2 W, for irrigation of 40 acres in Section 24.

Permit 2720, Application 5155 (San Joaquin County) Issued to Island Reclamation District No. 2062, Banta, Calif., February 16, 1927, for 49.24 cubic feet per second from San Joaquin River, Old River and Dredger Cut in Paradist Cut in Section 4, T 2 S, R 6 E, Section 32, T 1 S, R 6 E, Section 30, T 1 S, R 6 E, Section 36, T 1 S, R 5 E, and Section 6, T 2 S, R 6 E, for use for irrigation of 3939.4 acres near point of diversion. Estimated cost $60,000.

Permit 2721, Application 5282 (Butte County) Issued to C. M. Faris Estate, Sacramento, Calif., February 16, 1927, for 16.4 cubic feet per second from Lateral "E" of Reclamation District 833, in Section 26, T 18 N, R 2 E, for irrigation of 656.2 acres of rice near point of diversion. Estimated cost $2000.

Permit 2726, Application 5229 (El Dorado County) Issued to Dr. A. L. White, Placerville, Calif., February 25, 1927, for 150 acre feet per annum from Shingle Creek in Section 19, T 11 N, R 10 E, for irrigation of 60 acres in Section 19.

Permit 2727, Application 5269 (Stanislaus County) Issued to C. C. Crookshank, Modesto, Calif., February 25, 1927, for 2.54 cubic feet per second from Tuolumne River in Section 17, T 4 S, R 8 E, for irrigation of 213 acres in Section 17. Estimated cost $3500.

OREGON

Among the more important applications for permit to appropriate water filed in the office of Rhea Luper, State Engineer of Oregon, during February, 1927, were the following:

Clyde Thomas of Salem, covering the appropriation of water from an unnamed stream, tributary of North Fork Santiam River, for irrigation of 40 acres in Linn County.

Ralph E. Williams of Portland, covering the appropriation of water from Ditch Draining Springs for irrigation and sub-irrigation of 15 acres in Marion County.

M. L. Jones of Brooks, covering the appropriation of water from Rock Creek for irrigation of 25 acres in Gilliam County.

E. A., and J. C. Hayes of Salem, covering the appropriation of water from Carnes Ditch for irrigation of 30 acres and manufacturing purposes in Marion County.

W. A. Hogue of Selma, covering the appropriation of water from An Unnamed Stream for irrigation of 16 acres in Josephine County.

Mrs. J. D., J. C. and O. M. Hooper of Midland, covering the appropriation of water from Klamath River for irrigation of 992.87 acres in Klamath County.

Mattie F. Weimer of Long Creek, covering the appropriation of water from an unnamed stream, tributary of Long Creek, for irrigation of 36 acres in Grant County.

Wm. F. Brown of Fife, covering the appropriaton of water from Three Forks of Twelve Mile and Long Hollow Creeks for supplemental irrigation of 482 acres in Crook County.

J. B. Laber of Portland, covering the construction of the Shady Brook Reservoir for storage of 50,000 acre feet of water from McKay Creek; and the appropriation of the stored water for irrigation, power and do-

mestic or municipal water supply in Washington County.

Henry T. Barker of Payette, Idaho, covering the appropriation of waste water from Payette-Oregon Slope Irrigation District for irrigation of forty acres in Malheur County.

Joseph Wittum of Eugene, covering the appropriation of water from Debrick Slough for irrigation of 22 acres in Lane County.

W. J. Walker of Gold Beach, covering the appropriation of water from Crook Creek for irrigation of 20 acres in Curry County.

Martin J. Wilcox of Portland, covering the appropriation of water from an unnamed tributary of Yew Creek for irrigation of 20 acres in Josephine Co.

Oregon Agricultural College of Corvallis, Oregon, covering the appropriation of water from Oak Creek for the irrigation of 150 acres in Benton County, at an estimated cost of $800.

Mr. W. S. Ayres of Prineville, Oregon, covering the appropriation of water from Crooked River for the irrigation of 100.25 acres in Crook County, at an estimated cost of $500.

Mr. A. N. Davis, J. O. Mark, and G. D. Allen of Odell, Oregon, covering the appropriation of water from a spring for domestic use in Hood River County, at an estimated cost of $5,000.

District Plans Canal Purchase

Purchase of the $250,000 irrigation canal and water rights of the Stockton Mokelumne Canal Company is virtually assured, according to an announcement from the Woodbridge Irrigation District, California, that it has signed up sufficient acreage to bond itself for the purchase. A total of 13,000 acres were in the district when its farmers decided to purchase the canal system. One thousand acres in addition were signed up.

Reports Lower Water Cost

The Glendora Consolidated Mutual Irrigating Company, Glendora, California, at its annual meeting in February, reviewed the complete record of business done during the preceding year. The comparison statement since consolidation, submitted by the company's secretary-treasurer, E. W. Parrish, showed that the net cost of furnishing water to the stockholders was considerably lower than it has been for several years past.

Big Sewer Job Ahead

Bids for the construction of a new sewer system that will cost approximately $198,000 have been called for by the city council of Auburn, Washington. They will be opened March 22. The new system will cover the south and eastern sections of the city which are now without sewerage facilities.

Stephen Griset has been elected director of the Delhi drainage district, Orange County, California, from division 2. Mr. Griset served as president of the board of directors of the district for twelve years, from 1907 to 1919.

A New Rig for Deep Drilling

(*Continued from Page 29*)

and the sand line mast is securely anchored to the mast. The drilling and sand lines are then reeved through their proper sheaves. The back legs are pulled back into place and guyed, and the rig is ready to operate.

Working Strains

All working strains on the mast due to the action of the walking beam are controlled from two points. The back legs, consisting of 3-inch I beams, are toed in to the mast at the highest point possible. These take care of any backward thrust. A ⅜-inch guy line, tensioned by a turnbuckle, is stretched from the bottom point of the back legs to the mast at the line of the idler shaft. At this point all movement tendency of the mast is outward, due to the forward pull of the lines over the idler sheaves. As the front of the mast is tightly secured to the sandline mast and from there to the platform, the entire rig is braced and can only move as a unit. By these two sets of members, the mast is kept absolutely rigid.

It has been found that the weight of the mast, together with the action of the tools, will cause the sill timbers to crush under the mast, thereby letting the mast sag either to one side or the other, and distorting all of the supporting shafts and allowing the tools to drill to one side of the hole. This invariably results in a crooked hole with its consequent liability of trouble. To overcome this sagging of the mast, metal covered hardwood blocks are inserted at the bottom of the mast legs. These blocks are about 10 inches high, have a ¾-inch taper cut on the top, and the ends of the mast are also tapered to suit. When the mast is in the vertical position the chucks when inserted are pulled up with a bolt that securely locks the mast and at the same time, all previous misalignment can be corrected.

This rig is powered with a 45 H.P. type E. U. L. Waukesha motor with Ricardo head. The gasoline tank is mounted above the motor and the entire motor is mounted on slides with adjusting screws so that it may be moved forward and backward in order to maintain correct tension on the belt. The motor is mounted on the bottom sills of the rig and is at the extreme rear. This location provides easy access to all parts of the motor, and a better balancing of the weights on the rig timbers is also obtained.

It is believed that as this type of drilling equipment increases in portability and speed of operation, new uses will be found to justify further refinements in construction.

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Standards for Pool Design and Operation

(*Continued from Page 27*)

should be provided for each swimmer who may be expected to be present at time of maximum load.

D. In computing the area to be provided for persons who do not swim we must take into consideration the character of the pool. At indoor pools and small outdoor pools this area should probably be included with the swimming area and the crowding limit computed as such. At large outdoor pools where a consider able proportion of the water is shallow water, we may assume that 50 per cent of the non-swimmers would be on shore. The average space allowance for each non-swimmer in the water is approximately one-half that of the swimmer in deep water. Combining these factors an allowance of 10 square feet per bather should be allowed for this portion of the pool.

Inlets and Outlets

A. All pools should be provided with an outlet at the deepest point of sufficient size to permit the pool to be completely drained in four hours or less. Outlet opening in the floor of the pool should be at least four times the area of the discharge pipe to reduce suction currents. This opening must be covered with a proper grating.

B. In the rectangular pools with deep water at or near one end, multiple outlets should be provided where the width of the pool is more than 20 feet. In such cases outlets should be spaced not more than 10 feet from side walls.

C. Proper pipe connections must be provided in recirculation pools to permit water being drained directly to the sewer, as well as to recirculation pumps. In making connections of pool outlets with sewers proper care must be taken to prevent any possibility of sewage from the building or from outside backing up into the pool.

D. Inlets for fresh or re-purified water should be located to produce as far as possible a uniform circulation of water throughout the entire pools. In semi-artificial pools of irregular shape a careful study should be made of probable circulation currents and inlets located and spaced to provide as complete circulation as possible. All inlets should be located at the shallow water portion of the pool and not more than 1 foot below water line, except in case where reverse circulation is used as discussed in paragraph H.

E. Where the distance across the shallow portion of the pool is more than 20 feet, multiple inlets must be provided, so spaced that each inlet will serve a linear distance of not more than 20 feet. At spoon shaped rectangular pools where the outlets are located more than 5 feet from the end wall, inlets should be placed at both ends of the pools. At large pools with outlets near the center, inlets should be placed at the specified intervals entirely around the perimeter of the pool.

F. In small rectangular pools with only a singlet inlet and a single outlet, inlet and outlet should be located on a line drawn lengthwise through the center of the pool. Inlet orifices located at or below normal water level should be covered with a grating having openings of at least twice the orifice area.

G. Each inlet should be designed as an orifice and proportioned to supply the volume of water required at that particular point to obtain the best circulation. Inlet piping should be designed to provide at least twice the area of the inlet orifice. In large pools the inlet pipe system should be designed in sections with gates to permit regulation of the flow to different inlet orifices.

H. In a few cases pools have been designed for fresh water or re-purified water to enter at the deep point and overflow through outlets or scum gutters in the shallow portion. It is believed there may be some advantage in having flow through the pool in this direction, thus permitting floating matters and dirtier waters from the more crowded shallow area to be carried off more rapidly. The committee suggests that in designing piping systems for recirculation or flowing through pools, cross connections be provided so that flow through the pool may be in the direction which experiments may prove most desirable. It is also suggested that the question of having scum gutters serve as overflows and outlets in recirculation or flowing through systems be studied more carefully, as it appears that such design may have certain material advantages.

Scum Gutters

A. Scum gutters should extend completely around the pool. The design of scum gutters should be such that matters entering them will not be washed out by a sudden surge of entering water, and that danger of bathers catching arms or feet in them be reduced to a minimum. The edge of a scum gutter should be designed to serve as a hand hold for bathers. Gutters should, therefore, be sufficiently deep that bathers' fingers will not reach to the bottom. Sufficient opening must be provided to permit mechanical cleaning of the gutters.

B. Drainage outlets should be provided at least every 10 feet and the gutter bottom should pitch slightly to these outlets. Outlets and outlet pipes should be of generous size to permit rapid carrying away of water during surface flushing or reversed flow. Drainage from scum gutters may be conducted directly to sewers or to suction of recirculating pumps. Both such connections are advised.

C. All scum gutters should be recessed into the pool wall. There is no legitimate objection to having scum gutters project slightly into the pool to permit drainage from runways to flow directly over the edge of the pool into them. Such projection should not, however, be more than 2 inches.

Steps, Ladders and Step Holes

A. Steps or stairways for entering and leaving the pool should be of such construction as to minimize danger of accidents. Ladders or stairways should be located at one or both sides of the deep end of the pool. If the distance from the bottom of the pool to runway is more than 2 feet, a ladder or steps should also be placed at the shallow end of the pool. Treads of ladders or steps should be of non-slip material.

B. In some pools ladders have been replaced by step holes inserted in the pool wall. If step holes are provided, they should be of such design that they may be readily cleaned and be provided with drains into the pool to prevent accumulation of dirt.

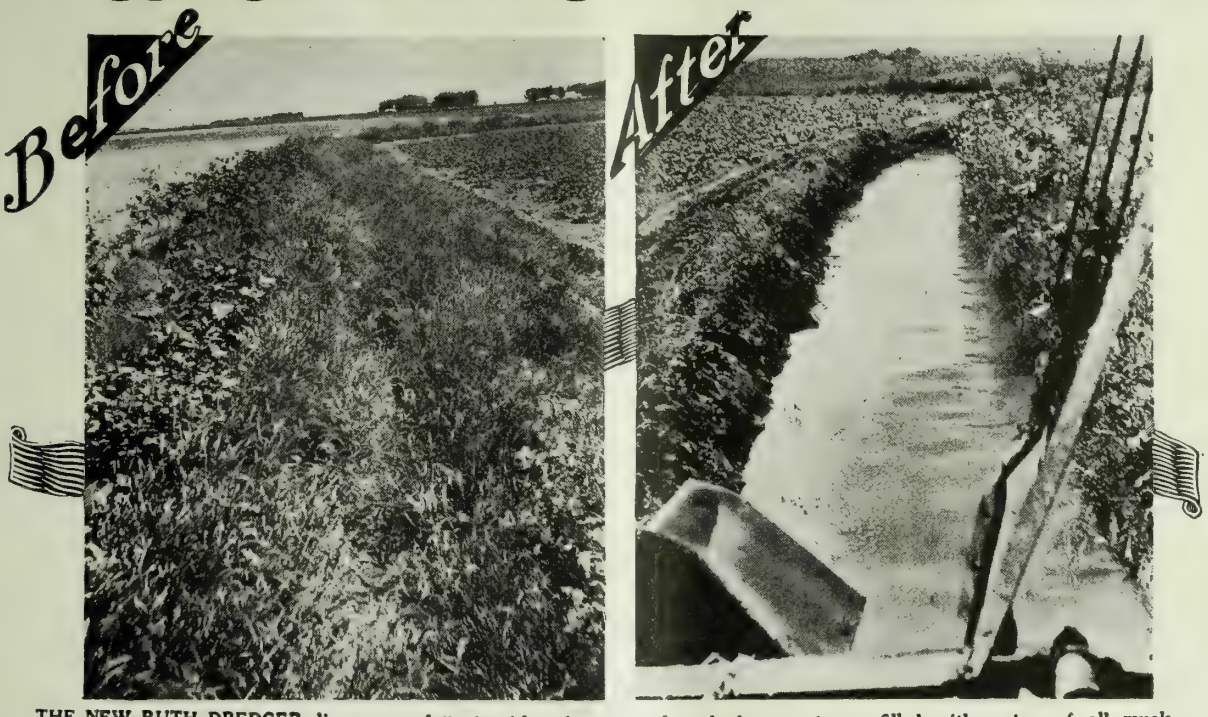
C. Stairs, ladders, or step holes should have a hand rail on either side at the top leading out over the runway. Stairs should not project into the pool. If stairs are desired, the stairway should be recessed into the wall and the runway of the pool.

Runways or Sidewalks

A. Runways not less than 4 feet wide should extend entirely around the pool. Runway floors should have a slope of about ¼-inch to the foot, should be smooth and easily cleaned, but should be as far as possible of non-slip construction. The edge of the pool runway must be of non-slip construction for a width of at least 1 foot. The edge of the pool at its junction with the runways should be rounded. At indoor pools, unless runways are very wide, handrails on the outside wall are desirable.

B. The older practice was to require runways of all pools to slope away from the pool with drainage vents at intervals connecting with the sewer. Such a requirement seems unnecessary for indoor pools. The water carried out on runway

Digging, Cleaning Canals - *at Low Cost*



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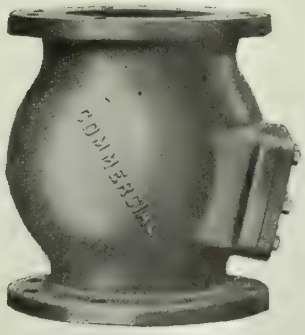

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For General Hydraulic Equipment Listings, See Last Page

For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

Advantages of Metering Irrigation Water

1.—It provides an equitable and just basis for all water users on which to pay their portion of the cost of operating their canal system.
The farmer who uses less water by the meter system pays less in proportion than the farmer who uses more.
2.—It provides a means of knowing how much water is applied to a field or crop. The U. S. Department of Agriculture and State Experiment stations have many times shown that the quantity of water applied to a crop sensitively influences the yield. The Universal tendency and danger is to irrigate too heavily.
3.—It encourages the farmer to save water by better field and ditch preparation.
4.—It allows him to use as much as he likes and gives it to him when and as often as he wants it.
5.—It increases the water supply by eliminating wasteful tendencies.
6.—It creates better harmony among water users and co-operation between them and the canal operators by providing a fair and just means of measurement which is beyond dispute.
7.—It will often prevent the development of seepage lands due to the removal of extravagant irrigation practices among users on new projects. This saving is often many times the cost of a meter system.
8.—The general effect of metering irrigation water is to reduce the cost of canal operation, increase irrigation efficiency, stop complaints, create better crops, and avoid expensive drainage works.
9.—The metering of irrigation water pays big dividends to the irrigators from the day it starts and always keeps on paying.
10.—The principle is sound and is being widely adopted.

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is of the same character as that in the pool. Modern trend of opinion is toward having runways of indoor pools slope toward the pool with drainage into scum gutter or scum gutter drainage system. At outdoor pools so located that much dirt is blown in from outside it is desirable to have the runways slope away from pool to permit flushing such dirt directly to the sewers.

C. Some sanitary authorities also require a raised edge 2 inches or more in height between the pool and runways. Such a raised edge may lead to accidents by bathers tripping thereon and cannot be recommended for indoor pools. At outdoor pools a raised edge forms a barrier between pool and runway and permits the use of greater hose pressure for flushing. If installed for this purpose, such an edge should be not less than 1 foot wide and at least 6 inches high in order that danger of accidental tripping may be reduced as much as possible.

D. High, tight walls should encircle the pool outside the runways. Some outdoor pools have been constructed with areas of sand or grass and shrubbery just outside the runways. This practice is objectionable as it leads to tracking of much dirt into the pool. Trees and shrubbery overhanging or adjacent to the pool or runways are also objectionable and may cause unnecessary dirt in the pool.

Visitors' Galleries

There must be an absolute separation of the space used by spectators and that used by bathers. There should be no means by which bathers can enter space reserved for spectators or vice versa. Visitors' quarters must have a separate entrance. Galleries for spectators should not overhang any portion of the pool surface. Floor and foot rail of the gallery should be of tight construction to prevent dirt tracked in from getting into the pool. Gallery floor should slope to a drain and should be flushed down with hose regularly. Seats in galleries should be of non-absorbent construction to permit washing.

Dressing Rooms

A. Bath houses to be used simultaneously by both men and women should have two parts, one for each sex, entirely separated by tight partitions.

B. Floors of all dressing rooms and locker rooms should be of smooth finished material, impervious to moisture, with no open cracks or joints. All floors should have a pitch of about ¼ inch to the foot and should slope to a proper drain to permit washing down with a hose. All junction of the floors with side walls and partitions should be finished with rounded joints.

C. Walls and partitions of all dressing rooms and locker rooms should be of smooth, impervious material, without open cracks or joints. If walls of wood or similar material are used, all cracks and joints should be filled and the surface kept finished with paint or other sanitary waterproof coating. Partitions between dressing compartments should terminate not less than 4 inches above the floor to permit flushing of the entire floor area.

D. All furniture used in dressing rooms should be of simple character and of easily washable material. Lockers where provided should be of vermin proof construction with tight joints. All lockers should be properly ventilated.

E. All dressing rooms and appurtenances must be kept clean at all times. The use of a vermifuge spray for lockers and of a disinfectant on floors, walls and seats at frequent intervals is recommended. Foot tubs in dressing rooms at beach houses should be prohibited.

Showers, Toilets, Lavatories

A. Adequate shower bath facilities with hot and cold water must be provided at all artificial pools. The minimum number of showers provided should be in the proportion of one for each 40 bathers expected at time of maximum load. At pools where mixed bathing is permitted it can usually be assumed that two-thirds of bathers at time of maximum load will be men.

B. Shower baths should be of such design that a proper mixture of hot and cold water may be obtained without danger of scalding the bather. A Bidet or upward flow spray beneath each shower to permit washing between the legs is desirable.

C. A foot trough with running water is desirable at entrance to outdoor pools and to beach bath houses. At certain pools operated in conjunction with surf bathing, it has been found advisable to make a wading pool of the entrance passage with automatic or continuous flow showers overhead, through which all bathers must pass on return to the pool.

D. At public bathing beaches a sufficient number of showers should be provided to permit all bathers to rinse off sand and dirt before entering the dressing rooms.

E. Adequate and proper toilet facilities for each sex must be provided at all pools and beach bath houses. The minimum number should be one toilet for each 40 women and one toilet and one urinal for each 60 men. Urinals should be of a type that will not cause splashing of urine upon legs and feet of bathers.

F. Water flush toilets should be used wherever possible. Chemical closets may

be used if proper sewage disposal is lacking. All closets and urinals must be properly serviced. Privies of any type are not recommended for public bathing places.

G. Lavatories located adjacent to toilets should be provided at all swimming pools in the proportion of one bowl to each 60 persons using the pool at time of maximum load.

LIGHTING, VENTILATION, HEATING

A. A complete system of artificial lighting must be provided for all pools bathing beaches, bath houses and dressing rooms which are to be used at night.

B. Lighting fixtures must be of such number and design as to light all parts of the swimming pool and the water therein.

C. Arrangement and design of lights must be such that life guards may see clearly every part of the bathing waters at a beach or pool, and all spring boards, towers, floats, and other appurtenances, without being blinded by the light.

D. Indoor pools should be so located that they may be lighted during the day by windows on at least one side or by skylight. The window or skylight area should not be less than one-half the area of the pool including the runways.

E. All indoor pools and all bath houses, dressing rooms, shower rooms and toilets at both indoor and outdoor pools and beaches, must be properly ventilated. Ventilation of indoor pool rooms must be so designed that direct draft will not blow on bathers.

F. At all indoor pools except those so located that outside temperature never falls below 60° F. the pool room and all dressing rooms, shower rooms and toilets should be artificially heated to a temperature of between 70 ° F. and 75° F. Thermostatic control of the temperature of the air in the pool room and of the water in the pool is desirable.

Lake Gets Huge Runoff

Reports from Lake Henshaw, San Diego County, California, late in February, stated that it caught 22,000,000 gallons of water during the storm of the preceding week, and that the run-off was lifting the lake level at the rate of six inches a day. This catchment is the largest of any reservoir in San Diego County.

Petition Goes to State Engineer

The petition for the formation of the Big Springs Irrigation District, California, has been heard by the board of supervisors and referred by them to the state engineer. Upon the return of the petition a public meeting will be called at which time any protests will be heard.

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OVERHEAD IRRIGATION

Light Portable Pumping Units Effect Economy in Small Installations

THERE has recently been developed a small portable pumping unit that makes overhead irrigation in individual sections of the farm more practicable. Many growers cannot use a permanent installation because of the high first cost, or because of the unwillingness to accept the annual overhead charge which such an installation would entail. The use of portable stands attached by ¾-inch garden hose to outlets carefully located on an underground distributing system provides for the convenience and benefits of overhead sprinkling without the high first cost of a permanent installation.

There is no standard design for portable sprinklers. In most cases growers build sprinkler stands from materials at hand and cap them with purchased sprinkler heads. In some cases the riser pipe is mounted on a light wooden platform by means of a bend elbow. Guy wires run from the corners of the stand to the top of the riser. A tee or elbow fitted with a hose-thread adapter, allows for the connection of a supply hose.

Another common type is made entirely of pipe and áttings. A ¾-inch pipe cross, fitted with three-foot lengths of ¾-inch pipe, furnish the base. The riser pipe starts from a tee connected to one arm of the cross by a short nipple. Three of the arms from the cross are sealed by caps, while the fourth is fitted with hose thread adapter which allows the entrance of water. Guy wires are essential for all types of portable stands.

It is evident that great economy can be effected by the use of portable sprinklers. They can either be connected to a semi-permanent installation of underground piping, or temporary lines run along the ground to connect up the portable system. In such a system, long arm sprinklers that deliver relatively large quantities of water are ordinarily used. Six portable sprinklers are usually operated at once, and only that number need be provided for the usual ten-acre installation. Economy can be gained by designing the underground pipes so that each lateral carries but one sprinkler, rather than by locating all the sprinklers along one lateral and finishing the zone within reach of the lateral before the next is begun.

AN EVINRUDE ENGINE ATTACHED TO A CENTRIFUGAL PUMP MAKES AN IDEAL PUMPING UNIT FOR PORTABLE OVERHEAD INSTALLATIONS.

In connection with such portable installations, there has been developed a small portable pumping unit, with an approximate weight of only 115 pounds, and occupying a space of 17 by 23 inches. The outfit consists of two main parts, the pump proper, and the small gasoline engine that is used for the power. The pump has but one moving part, that being the impeller. This pump is of the high speed type, and is properly balanced so that there is no vibration to cause trouble. The ignition is furnished by the magneto, which is built into the flywheel where it is free from trouble. This unit cannot be damaged by dampness or rain, and is so light that it may be suspended over an irrigation ditch or well by means of a rope or scaffold and yet function perfectly. This unit is built to deliver 70 gallons per minute which is sufficient to comfortably take care of a small overhead installation. As the initial investment and upkeep are small, the economy effected is appreciable, and the unit is rapidly finding its place where small portable installations are desired.

The last issue of MODERN IRRIGATION described an overhead irrigation system that was being made by the Browning Manufacturing Company of Los Ange-

(*Continued on Page 55*)

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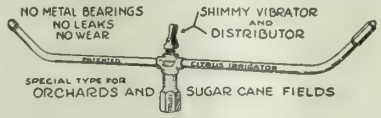

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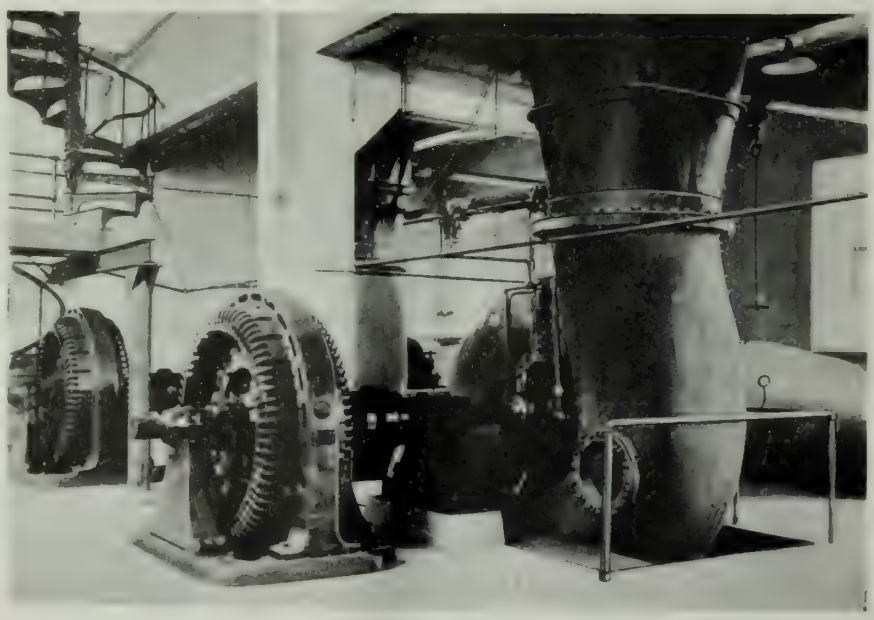
TRADE NOTES *of the* MONTH

48-In. Screw Pump Operating Against Head of 27½ Ft. a Feature of This Plant

THE Lakeside Irrigation Company, Eagle Lake, Texas, has been one of the most successful irrigation companies operating in the gulf states. Eagle Lake is located about 66 miles from Houston. The Lakeside Irrigation Company has two plants one of which is located on the Colorado River and pumps the water from the river into canals from which it is led a distance of five miles to a natural lake. At the lake is located a second-lift plant which picks the water up from the lake and distributes it over the land that is to be irrigated and upon which rice is raised.

The company has several hundred miles of ditches or canals for transporting the water. Each farm has its own gate for controlling the distribution of water over its land.



A CLOSE-UP OF THE NEW PUMPS

Two Worthington 48-inch centrifugal pumps of the screw type installed in the new Lake Plant of the Lakeside Irrigation Company. Each pump is direct-connected to a 600 h. p. General Electric synchronous motor, operates at 360 r. p. m. and has a capacity of 60,900 gallons per minute, against an operating head of 27½ feet. The pumps have vertical discharge outlets.

The second-lift plant, or Lake Plant as it is known, was recently reconstructed and electrified. The new building is one of the finest and best looking irrigation plants in the Gulf States. No expense was spared in buying the best equipment and in making the plant strictly up to date. This plant was originally steam-driven but now that electric motor drive is being used only one steam-engine-driven unit remains. This consists of a 36-inch Worthington centrifugal pump direct connected to a unaflow steam engine. This pump, which was designed for a capacity of 42,000 gallons per minute against a total dynamic head of 32 feet when operating at a speed of 155 r.p.m. is being used as a standby unit until another electric driven pump is installed.

When the Lake Plant was reconstructed a Worthington 24-inch centrifugal pump of the double-suction volute type which was originally put into operation in April, 1918, was changed as to pump speed and increased to 300 r.p.m. Under these conditions the pump has a capacity of about 18,500 gallons per minute. Despite the fact that the pump has already been in service eight years it is still giving complete satisfaction.

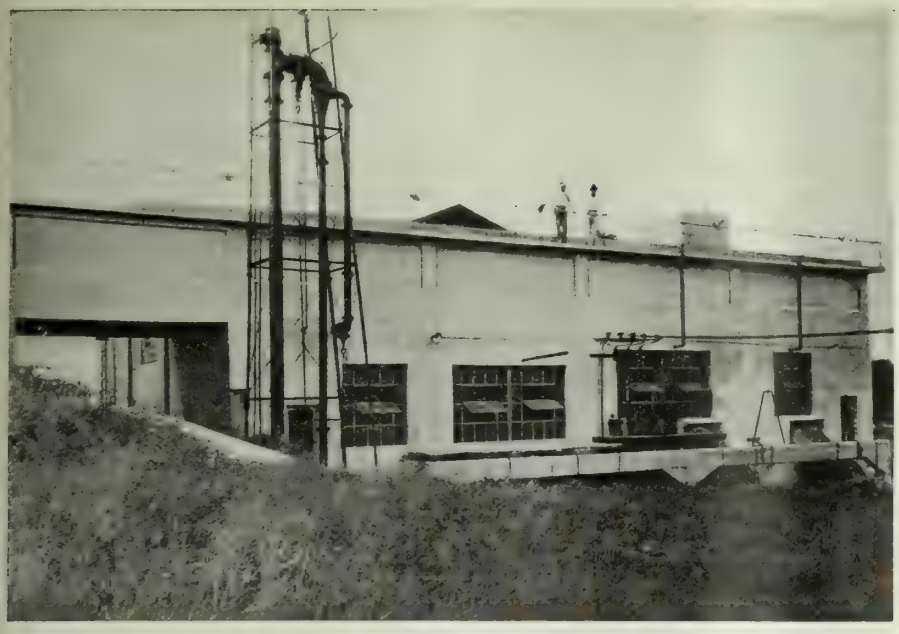
In reconstructing the plant two Worthington 48-inch centrifugal pumps of the screw type were installed. These pumps are among the first large electrically driven screw type pumps used for irrigation service, in the gulf states. Each of the pumps is direct-connected to a 600 h.p. General Electric synchronous motor operating at 360 r.p.m. and each delivers 60,900 gallons per minute against an operating head of 27½ feet.

Under actual operating conditions with discharge head of 27½ feet the pumps each have a capacity of 60,900 gallons per minute. These pumps completed the entire irrigation season from May to October, 1926, with perfect satisfaction, and exceeded the original efficiency guarantees.

River Plant Being Electrified

The River Plant during the 1926 irrigation season was steam engine driven. The plant is now being reconstructed and electric motor driven pumping equipment will be installed.

This plant contained a 45-inch Worthington horizontal centrifugal pump of the volute type located in a pit and driven by rope drive from a Corliss engine. This pump was designed to deliver 50,000 gallons of water per minute against a total head of 28 feet. In this plant there is also a 36-inch centrifugal pump rope driven by a Corliss engine.



AN EXTERIOR VIEW OF THE STATION

Rear view of Lake Station of the Lakeside Irrigation Company showing suction pipes. At the top of the building where two men are standing is a concrete flume which carries the water delivered by the pumps to the irrigation canals and ditches. This illustration also shows Worthington Barometric Condenser which is used in connection with the steam driven unit held as a reserve.

The new pumping equipment will consist of three Worthington 48-inch horizontal screw pumps each direct-connected to 700 h.p. General Electric synchronous motors. Two of the pumps will be operated at a speed of 327 r.p.m. while the third pump will be operated at a speed of 360 r.p.m.

The pumps will be located in a concrete pit 20 feet below ground level and each will be capable of handling approximately 60,000 gallons of water per minute against heads up to 34.5 feet.

The 36-inch steam driven centrifugal pumping unit has already been removed. The 45-inch Worthington centrifugal pump driven by rope from Corliss engine will be retained for the present as a stand-by unit, but will be eventually converted to motor drive.

The new River Station will be as attractive as the Lake Plant. A concrete and hollow tile building, according to present plans will be erected over the pump pit. The switchboard, motor-generator exciter units for the synchronous motors and other auxiliaries will be located on the floor level or on a mezzanine floor. No expense is being spared in making the plant modern in all respects.

Will Have New Water System

Buckley, Washington, hopes to have its new $50,000 water system ready for use by July 1 of this year. The city council has issued a call for bids—on the job as a whole, and on material and labor separately. The council voted to call in a consulting engineer to go over the entire proposed system.

Overhead Irrigation

(*Continued from Page 52*)

les, for Dr. Frank Grey at his ranch near Riverside, California. This installation has since been completed and the construction crews moved to an adjoining rancho known as the Kellem estate, where a new five-acre installation is being made.

The overhead system of irrigation is not new on the Kellem estate, as some time ago they placed thirty acres under overhead, and have been very well pleased with the results. While the work on the additional five acres was under way, the construction crews revamped the old system, and installed about 385 new heads. These were the Browning type heads, and were placed under the direction of the company's engineers.

Asks Rate Increase

The Haines Canyon Water Company, operating in the vicinity of Tujunga, Los Angeles County, has applied to the California Commission for an increase of rates, alleging that the present rates are inadequate, and to collect a surcharge of 20 per cent temporarily pending adjustment of its rates.

Bay Companies Will Exchange Land

Spring Valley Water Company has applied to the California Railroad Commission for permission to exchange a small parcel of land with South San Francisco Land and Improvement Company for the purpose of granting the latter company a pipeline right of way.

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6″ Well pump	150	75	5
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8″ Well pump	275	70	7½
8″ Well pump	350	67	10
10″ Well pump	600	75	15
12″ Well pump	800	75	20
12″ Well pump	1000	70	25
12″ Well pump	1200	75	30
14″ Well pump	1000	128	40
14″ Well pump	1200	135	50

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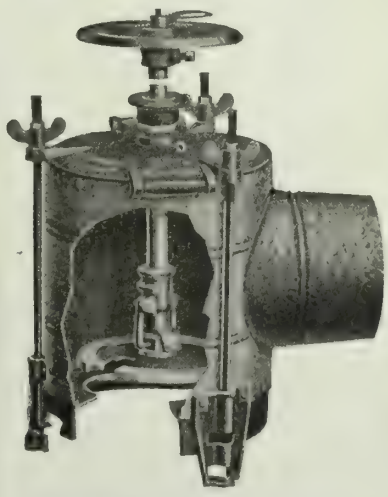

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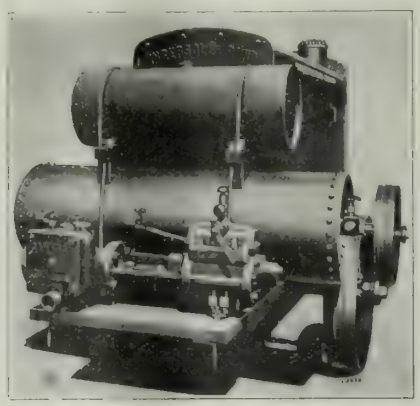
Portable Compressor-Pump

The Ingersoll-Rand Company has perfected a new combined portable air compressor and water pump outfit. It consists of a standard Type Twenty gasoline-engine-driven portable compressor and a Cameron air-driven pump. It is particularly suitable for dewatering jobs, and can be used successfully for the elevation of water, for removing the overnight accumulation in ditches and excavations, for cement gun service, and for furnishing water to concrete mixers, etc. The portable compressor, in addition to supplying air for the pump, will run such air tools as "Jackhammer" rock drills, paving breakers, clay diggers, portable hoists, drill steel sharpeners, etc.



A VIEW OF THE PORTABLE COMPRESSOR-PUMP OUTFIT

This new outfit, the manufacturers explain, fills the long-standing demand for a truly portable pump, one that can be easily removed from place to place as it is needed. As the illustration shows, the outfit is portable in every sense of the word, the pump being mounted on the frame of the compressor adjacent to its source of power. The pump is positive in action, starting up just as soon as the air is turned on. It requires no priming and will handle very muddy water. It can also be regulated to any desired capacity within its maximum rating by adjusting the amount of air admitted.

Ingersoll-Rand, in their descriptive bulletin, go on to say:

"Practically all of the pumping equipment in use today by contractors and public utilities consists of a pump and some form of independent prime mover, usually a single-cylinder gas or oil engine. This means two pieces of machinery which must be moved and set up each time the pump is needed. It also means two separate pieces of equipment which must be kept in perfect condition so that the pump will be ready to go to work whenever it is required.

"Most jobs now require compressed air and a compressor is, therefore, generally available. The advantage of having an air-driven pump mounted right on the compressor are at once apparent, as this arrangement eliminates the gas or oil engine which was formerly used to drive the pump. With this new outfit, the pump is ready for work whenever the compressor starts up. The unit can easily be moved from place to place as occasion demands.

"Several sizes of these compressor-pump outfits are available. It is also possible to obtain the pump alone, together with all parts necessary for attaching it to any Ingersoll-Rand Portable now in the field."

Seek Drainage Plan

Van Nuys, California, and Mission Acres, three miles north, were severely swept by drainage waters during the February storm. To prevent a recurrence of this in future years it has been decided to start some plan for a huge drainage system to take care of the great amount of water that sweeps through the central part of San Fernando Valley with each rainy spell. Committees from both towns have begun work to enlist the cooperation of a group of 100 property owners who will subscribe $50 each toward a fund to employ private engineers to work out a definite drainage plan.

Sale of Water Rights Planned

Negotiations are under way for the sale by Miller & Lux, Inc., of certain of its canal and water rights to the San Joaquin River Water Storage District for a consideration in excess of $10.000,000, according to a recent announcement through Peirce, Fair & Co., bankers for the company.

Ernest H. Burgess, of Roosevelt, Utah, was re-elected president of the Dry Gulch Irrigation Company at the annual stockholder's meeting in February. C. W. Smith was elected vice president, and Ray E. Jordan, treasurer. The position of secretary is appointive.

Seek Deeds for Right of Way

Preliminary steps toward securing deeds for the right of way from Adrian, Oregon, to the dam site for the Owyhee dam have been taken by the engineering department and attorneys of the Reclamation Service.

J. V. Mendenhall, State director of the California Real Estate Association, and one of MODERN IRRIGATION's advisory board, has been elected president of the Stockton Chamber of Commerce, succeeding Irving Martin.

For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

Equipment in Sewage Plants

(*Continued from Page 32*)

the screens instead of attempting to utilize gravity flow with the screens set at the sewer level. Even if the coarse screening is taken care of at the gravity flow level the pump should be used for delivery to the fine screens. One disadvantage of the centrifugal pump for this service is the fact that it tends to break up the solids, thus reducing the effectiveness of the fine screens.

Pumps for handling the effluent are ordinary centrifugals, while the sludge pumping problem is similar to that in the sedimentation plant.

Compressing the air used for aeration requires more power than any other single step in the process. Several types of blowers or compressors have been used for pressures of 5 to 10 pounds per square inch. The amount of air needed varies from 0.6 to 3.5 cubic feet for each gallon of sewage treated; this depends on many factors, chiefly local conditions. Part of the blower units are driven by slip-ring induction motors for speed adjustment; the rest use constant-speed squirrel-cage induction or occasionally synchronous motors.

Other motor-driven machinery includes: Revolving screens, often with rotary brushes; slowly rotating paddles on the flat bottoms of settling tanks to scrape the settled sludge to the central outlet; rotating drum type vacuum filters; belt and screw conveyors for handling the sludge after filtration; cylindrical driers revolved at low speed; crushers to break up lumps of the dried sludge into marketable size as fertilizer; bag fillers may be used for the latter. At Milwaukee a travelling crane and grab bucket is used in storing the fertilizer over the winter. All this machinery is electrically driven, for the most part by squirrel-cage and in fewer cases by slip-ring induction motors.

In the foregoing descriptions of the two leading processes an attempt has been made to describe only the most important features as carried out in the latest installation. Due to the continual development work going on, the plants differ more or less in detail. Some works use a combination of the two processes. There is a wide variation as to disposal of the sludge. Its use as fertilizer on a commercial scale has been effected only a few years, but seems to haye an assured future.

State Senator Herbert S. Auerbach, of Utah, in a recent address before a meeting of the Salt Lake Rotary Club, discussed the Colorado River problem and the main features of the Swing-Johnson bill.

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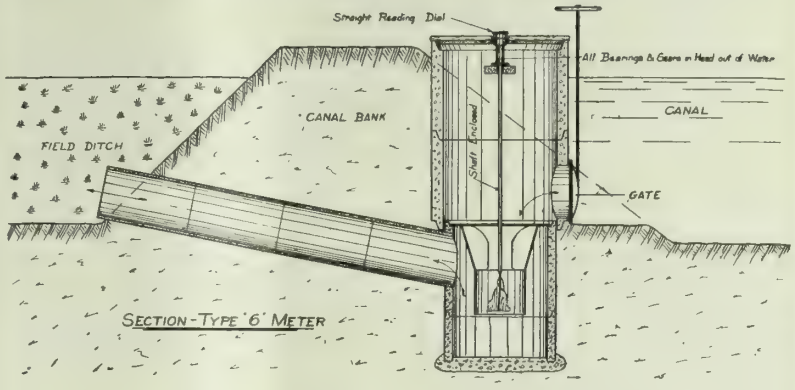

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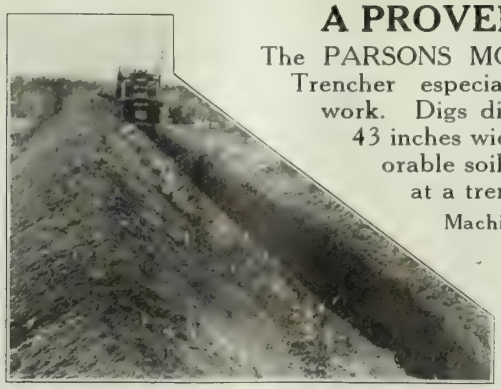

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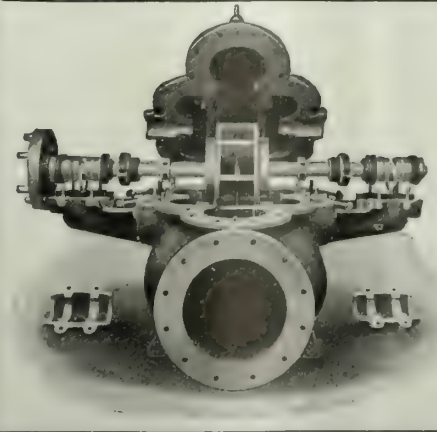

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AMONG OUR CONTRIBUTORS

Editorial Jottings About Current and Forthcoming Feature Articles, Dealing With Practical Problems of Hydraulics, and the Men Who Have Written Them

L. M. LAWSON

L. M. LAWSON, author of the article in this issue on "The Rio Grande Federal Irrigation Project," was born in Washington, D. C., and received his technical education in California at Throop Polytechnic Institute, Pasadena, and Stanford University.

He was among those first appointed to the United States Reclamation Service at its inception in 1902, and has served on several projects from that date to the present. His first work was accomplished in charge of a survey and topographic party, mapping the Colorado River in 1903 and 1904 at various points between the site of the proposed Boulder Canyon Dam and Yuma, Arizona.

From 1906 to 1913 he was resident engineer on the Yuma Valley levee system.

From 1913 to 1915 he was project engineer in charge of the Rio Grande Project in New Mexico and Texas.

From 1915 to 1917 he returned to take charge of the Yuma Project as project engineer.

From 1918 to date he has been in charge of the Rio Grande Project, including its construction and operation and maintenance features. He is a member of the American Society of Civil Engineers and past president of the Southwestern Division, American Association of Engineers.

In addition to his project duties, he has been designated by the Secretary of the Interior as engineer representing the United States on international river rectification of the Rio Grande.

THE ARTICLE on swimming pools is a part of the report of the joint Commitee on Bathing Places, appointed by the American Public Health Association and the Conference of State Sanitary Engineers. This committee was composed of Stephen De M. Gage, chairman, Harry F. Ferguson, C. G. Gillespie, Richard Messer, E. S. Tisdale, Jack J. Hinman, Jr., and Howard W. Green, all of them sanitary engineers who have done much research work in the various lines in which each is particularly interested. Mr. Gage, the chairman, is chief chemist and sanitary engineer with the Rhode Island State Board of Health, a position he has held since 1914. He is a graduate of the Massachusetts Institute of Technology and for seventeen years was a member of the staff of the Lawrence Experimental Station. He is the author of various papers on the bacteriology of waters and sewage, also many papers on sanitary engineering subjects.

D. D. GROSS, whose paper on "Design of Distribution Systems," presented before the annual convention of the Rocky Mountain Section of the A. W. W. A., is published in this issue, is chief engineer for the Board of Water Commissioners, Denver, Colorado. Mr. Gross was graduated from the Colorado Agricultural College in 1903, and has been connected with the Denver water supply system almost ever since. He was first employed by the Denver Union Water Company to inspect cement used in the construction of the Cheesman dam, the bulwark of Denver's water supply. From that time on he has been a member of the engineering staff of the Denver Union Water Company and its successors, the Board of Water Commissioners. The plant of the Denver Union Water Company was purchased in November, 1918, by the city and county of Denver, and since that time has been operated under municipal ownership.

LEON T. ELIEL

LEON T. ELIEL, who contributes the article on aerial mapping, is Pacific Coast manager for the Fairchild Aerial Surveys, Inc. Mr. Eliel's connection with the field of aviation began with the entrance of the United States into the World War. He was a student in the University of California at the time, and left his work there to enter the air service. He was not sent overseas, but was stationed at various points in this country, serving for the longest period of time at San Diego. Since 1919 he has been continuously associated with aviation activities of various kinds, with particular emphasis upon the engineering angle of aerial photography. He has been in his present position as Pacific Coast manager of the Fairchild Company for two years.

CALIFORNIA

MODERN Irrigation

The Magazine of Applied Hydraulics

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Vol. III APRIL, 1927 **No. 4**

PROPOSED SITE OF THE DIABLO ARCH DAM, SEATTLE MUNICIPAL WATER PROJECT

Engineers' Report Ends San Gabriel Dam Controversy

What the Middle Rio Grande Project Means to New Mexico

What the Owyhee-Vale Project Means to the Northwest

Description and Plans for Los Angeles' New Sewage Plant

Three Big Water Purification Articles

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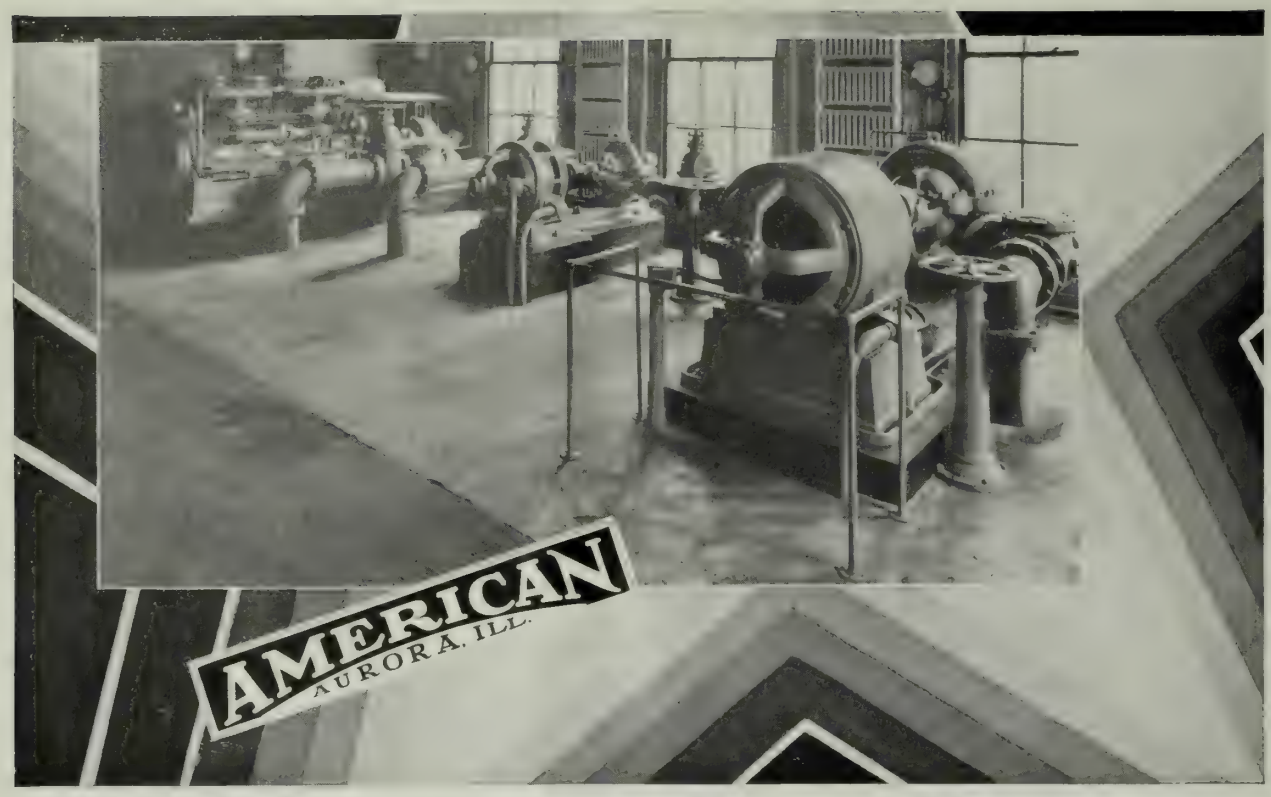

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All these motors are provided with Sundh automatic starters. This installation was made in 1924 and replaced the old steam-driven station that had been in service for a considerable length of time. City engineers should be interested in the economies effected. "American" engineers will be glad to furnish details.

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"Western Waterworks" Begins on Page 25 ☛

E. COURT EATON

Recently appointed chief engineer of the Los Angeles Flood Control District. Mr. Eaton is a graduate of McGill University, Montreal, and first came to California in 1913 to develop the water supply for the Panama Pacific Exposition. Later he became resident engineer on the Lindsay-Strathmore and Terra Bella Irrigation Districts, and was, as well, assistant engineer for the Merced Irrigation District. About five years ago he joined the California Department of Public Works, with offices at Sacramento, and it is that work which he leaves to assume his new duties.

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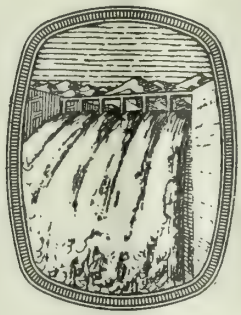

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The Progress *of* Irrigation

OUTSTANDING in the events of the month has been the settlement of the San Gabriel River flood control controversy through the submission of the report of the committee of three selected some months ago by the Los Angeles Chamber of Commerce and other organizations to make a survey of the whole subject of Los Angeles County flood control and particularly to settle once and for all the relative merits of the two proposed sites for the San Gabriel Dam.

The Committee of three selected to make the report was composed of three eminent engineers: F. H. Fowler, consulting engineer of San Francisco, formerly with the Federal Power Commission in California; Charles D. Marx, professor emeritus of civil engineering at Stanford University, chairman of the Arch Dam Test Committee, which built the experimental dam at Stephenson Creek, Calif., and at present consulting engineer on the Colorado River project; and Charles H. Paul, of Dayton, Ohio, engineer of the Miami Conservancy district and the builder of the Arrowrock dam erected by the United States Reclamation Service in Idaho.

The Board's report is printed at length on another page in this issue, but outstanding in their conclusions are that the proposed dam should be built at the Forks site rather than at the Granite Dike site; that the cost of the dam and the reservoir will be approximately $25,800,000; that other units of the project now built or contemplated, need careful replanning and that the Board of Supervisors has suffered from poor engineering advice as to a coordinated plan for the flood control project.

J. W. Reagan has resigned as chief engineer for the Los Angeles Flood Control District, but has been asked to serve on the new consulting board for the district. J. B. Lippincott, Los Angeles consulting engineer, has accepted a place on this board and Charles H. Paul has been asked to serve, but has indicated a desire to decline because of other duties which he feels would prevent him from giving the necessary time to the work. E. C. Eaton has been chosen to succeed Mr. Reagan as the district's chief engineer.

A measure which its authors declare will eliminate legal obstacles to development of water in California passed the Assembly by a vote of 68 to 8 on April 13. This measure declares that land

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owners adjacent to streams in the State are entitled only to the amount of water from the streams which they can put to beneficial use, thus limiting the riparian rights as interpreted in the recent Herminghaus decision. Assemblyman Crittenden, who led the fight for the measure on the floor, declared that the future agricultural development of California depends upon the adoption by the State of a new water policy. He explained that the bill would not deprive the riparian holder of any rights but would make it possible to utilize a huge volume of waste water that now flows into the sea. The measure was deadlocked in Senate Committee at press time.

Incidentally, the Southern California Edison Company has been successful in taking the Herminghaus case to the Supreme Court of the United States, according to press dispatches from the nation's capital. The history of the Herminghaus case is comparatively fresh in the minds of most readers, but can be reviewed briefly as follows:

The Edison company, with a federal water power permit and under the authority of the state water power act, sought to dam up the San Joaquin River and prevent both floods and dry season low water. Simas brothers, owning 28,000 acres of land on the river below, obtained an injunction on the ground that the high flood stage of the natural flow was necessary to bring water to their irrigation ditches.

The state lower court, in granting the injunction, held the California power act invalid. The state Supreme Court affirmed the decision, holding that the stream was navigable to a point above the proposed dam and that therefore no interference with the flow of waters was justified. The lower courts also held that shortage of water was not a legal "riparian owner" use of the water.

Winter precipitation in the western mountain regions has generally been near normal or above, with unusually heavy packing of snow, so that favorable stream flows may be expected far into the coming irrigation season. With the exception of the Okanogan project, an ample irrigation supply is assured for all Federal projects. The American Falls and McKay reservoirs, now nearing completion, will receive sufficient water to fill them if desired. Heavy snowfall in some localities, particularly in the Sierra Nevada region, may result in moderate floods. Average conditions prevail generally in the Colorado River drainage basin, but on account of the insecure flood control situation at the head of the Imperial Valley, such average conditions for flood run-off are menacing.

Diablo Canyon, Seattle Municipal Water Project. The Diablo Dam will be built here and construction work is to start at once. The above view was taken from a suspension bridge which is 135 feet above the water. The foundation for the dam have been thoroughly explored by the diamond drill, and is solid granite.

The Pan-Pacific Conference on Education, Rehabilitation, Reclamation and Recreation was held in Honolulu during the week of April 11-16. Secretary Work, of the Department of the Interior, and Dr. Elwood Mead, Commissioner of Reclamation, together with representatives of other departments of the Government and about fifty delegates from States and various national organizations, colleges and universities, made up the representation from the United States. Sectional group meetings were held for round table discussion of problems of education, reclamation and recreation. The reclamation group took up the new problems in engineering and the complex social and economic questions that are involved in irrigating and reclaiming arid lands.

Secretary Work, in his address of welcome, spoke of the mutuality of interest involving the nations participating in the Conference. "The Pacific," he said, "is a great combination of geographical, ethnological, and political factors, extremely diverse, but within them there is a spirit of human commonalty that encourages persistent efforts toward the germination of new and exalted ideals of civilization."

"Western Waterworks" Begins on Page 25

What the Middle Rio Grande Valley Project Means to Central New Mexico

Legislative Action Permits a Development Program of Major Importance; $5,000,000 to Be Spent on Irrigation and Drainage

THE recent appropriation by the State of New Mexico for the Middle Rio Grande Valley Project now makes possible a development which practically has been at a standstill for many years. The Middle Rio Grande Valley extends along the Rio Grande from San Marcial at the head of the Elephant Butte Reservoir of the United States Bureau of Reclamation, to White Rock Canyon, a distance of about 150 miles. It comprises a strip of land from one to five miles in width through which the river meanders from side to side, forming the lands into a series of natural units. This area is all in private ownership, and covers nearly 210,000 acres, inclusive of river beds, cities and towns.

The Middle Rio Grande Valley has urgent need for the following work, all of which is necessary if property values are to be conserved and if the valley is to grow and prosper in accordance with its possibilities:

(*a*) *Flood protection and river control.*
(*b*) *Drainage.*
(c) *Storage for supplementing irrigation needs.*
(*d*) *An adequate distribution system for irrigation.*

Because of the dire necessity of proper regulation of the river, and control of the flood waters of the district, the State of New Mexico enacted the Conservancy Act under which the Middle Rio Grande Conservancy District has been duly organized. Plans were then formulated to properly organize the forces, and engineers were engaged to make extensive studies of the whole situation, with the object in view of evolving an economical solution to the problem that was presented.

As can be readily seen, the work of preparing such a plan became an engineering study of the physical and topographical features of the valley and its drainage area. All of the available reservoirs had to be examined and compared so that the best might be finally selected, and a certain means of controlling the river had to be worked out. The irrigation and drainage systems had to be planned for, and appraisal data gathered. All of this work has taken time, and the entire plans are not even yet completed.

U. S. Cooperates

A contract has been executed between the Middle Rio Grande Conservancy District and the U. S. Bureau of Reclamation providing for water supply and silt studies for this area, to be made under the direction of the Bureau. Work is progressing under the provisions of this contract, and it is expected that a preliminary report will be made by the Bureau during the summer of 1927.

Preliminary studies made by engineers of the U. S. Bureau of Reclamation indicate that an adequate water supply may be secured for the district lands by the drainage of the water-logged lands of the valley. The loss of water by evaporation from the valley floor is estimated at over 500,000 acre feet per annum. This quantity is greater than the estimated average annual irrigation demand with the lands drained and the total area placed under modern irrigation. The amount of water now lost to beneficial use by excessive evaporation due to the water-logged condition of the lands is being carefully studied for the purpose of arriving at accurate figures, and it seems probable at this time that an adequate supply of water can be secured for all the irrigable lands lying within the floor of the valley.

Further assurance of an adequate water supply exists in the priority of the water rights of the valley lands, since these lands were practically all under irrigation at an early date, before the waters of the river had been diminished by other irrigation.

Storage Requirements

A further possibility for increasing the water supply exists on the Rio Chama watershed above the El Vado

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Middle Rio Grande Valley Irrigable Lands

(Estimated net area)

DIVISION 1 (Pena Blanca) White Rock Canyon to San Felipe

	Acres
Area above possible reservoir	2,997
Area subject to overflow 1 yr. in 12 yrs.	4,714
Total area subject to improvement (S. F. Reservoir Constr.)	7,711
Additional area if San Felipe Reservoir is not built	2,619
Total in Division	10,330

DIVISION 2 (Albuquerque) San Felipe to Isleta

	Acres
Bernalillo Distr. (East side)	9,460
Corrales Distr. (West side)	4,670
Albuquerque Distr. (East side)	12,380
Barr Distr. (East side)	5,157
Atrisco Distr.. (West side)	13,400
Total in Division	45,067

DIVISION 3 (Belen) Isleta to San Acacia

	Acres
Peralta Distr. (East side)	18,000
San Juan Distr. (East side)	9,774
Belen Distr. (West side to Rio Puerco)	29,968
San Francisco Distr. (West side below Rio Puerco)	2,880
Total in Division	60,622

DIVISION 4 (Socorro) San Acacia to San Marcial

	Acres
Lemitar Distr. (West side)	6,663
Socorro Distr. (West side)	3,933
San Antonio Distr. (West side)	12,050
San Pedro Distr. (East side)	3,150
Val Verde Distr. (East side)	4,995
Total in Division	30,791

reservoir site where three lakes located on the Jicarilla Indian Reservation may be drained at low cost into El Vado reservoir, thus saving the water lost by evaporation from these lakes. The area tributary to the lakes is approximately 175 square miles, or nearly one-third of the total watershed above El Vado. This area is inactive at present, since the lakes do not overflow except in occasional wet years.

About 70 per cent of the annual flow of the Rio Grande at the head of the valley occurs in the four months from April to July, inclusive. Since 1915 a dry river has obtained at San Marcial on the average of 39 days each year during the irrigation season. It is, therefore, evident that storage must be provided in order to secure an adequate supply of water during the irrigation season. The amount of storage necessary for this purpose is estimated at from 200,000 to 300,000 acre feet.

In addition to the storage requirements for irrigation purposes, a flood detention reservoir is considered of vital importance. The capacity of such a reservoir depends upon the maximum discharge which is to be permitted in the river channel through the district. It seems desirable to regulate the flow of the river from the head of the valley to the mouth of the Rio Puerco to a discharge quantity of approximately 15,000 second feet. In order to accomplish this, a maximum flood retention of 260,000 acre feet would have been required in 1920, the year of maximum recorded discharge. It is believed desirable to secure reservoir capacities of from 300,000 to 400,000 acre feet for flood control purposes. Such capacities would afford storage for larger floods than have heretofore been experienced during the years of record on the river. Flood storage will be most effective if located directly at the head of the valley.

Reservoir Investigations

The following reservoirs have been investigated and accurate surveys have been made to determine capacities.

Name	Area Acres	Capacity A. F.	Depth Water at Dam, feet	Location
State Line	18,500	350,000	90	Rio Grande above Colorado-New Mexico line.
El Vado	4,715	389,000	212	Rio Chama, below Parkview, New Mexico.
Buckman	12,000	540,000	130	Rio Grande above White Rock Canyon.
San Felipe	20,000	1,000,000	140	Rio Grande at San Felipe.
San Felipe	8,000	400,000	85	Rio Grande at San Felipe.
Rio Puerco	7,500	205,000	125	Rio Puerco below Railroad.

Borings have been made at the State Line and at El Vado sites, and open shaft work is now being done at El Vado for the purpose of determining foundation conditions. Designs are under way for dams at several of the above sites. El Vado appears favorable for irrigation requirements, and either San Felipe or Buckman for flood control purposes.

The meandering of the river from side to side of the valley floor and particularly the impinging of the stream at certain points against the hills has, as stated before, formed the valley into natural units. In some places the narrowing of the valley itself has caused a separation of the lands increasing the natural units. In the length of the valley there are twelve such districts, all of considerable size and importance. These natural units, rather than political subdivisions of Indian grants, counties, etc., control the design of the irrigation and drainage systems by fixing the location of diversion dams and to a great extent the arrangement of canals and drains.

Diversion Dams

Three diversion dams will be required to irrigate the valley lands located as follows: San Felipe, Isleta, and San Acacia. If the Indian lands of Cochiti and Santo Domingo are improved, one additional diversion dam will be required at the mouth of White Rock Canyon. These dams will all be on the Rio Grande. They will each be approximately 500 feet long and of the low weir type, raising the water surface from five to eight feet at low flow.

Each diversion dam will feed one or two main canals. These canals will distribute the water to the lands using the existing waterways for this purpose wherever possible. In the distribution of water it will be necessary to cross the Rio Grande by syphons or flumes at least five times. In some localities it will be possible to construct the new main canals above the present limit of cultivatable area, thus permitting the present irrigation works to function without interruption until the new system is in operation. The proposed system contemplates the consolidation of all the present ditches now heading into the river, about 60 in number, substituting therefore three or possibly four permanent diversions which may be maintained without excessive upkeep cost.

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It is proposed to accomplish the drainage and relieve the excessive alkalinity of the soil by the construction of a system of deep open drains such as have been found practicable at the Isleta Pueblo and on the lands under the Elephant Butte Dam. The proper functioning of these drains will be greatly assisted and the number of drains required will be decreased by the system of river control and regulation. This work will induce scour in the stream bed and decrease the present overflow of marginal river lands, thus enabling the river bed itself to function as a drain.

It is deemed practicable to regulate the flow of the Rio Grande throughout the portion of the valley above the mouth of the Rio Puerco to maximum discharge of about 15,000 second feet. This may be accomplished by a flood detention reservoir located either at San Felipe or Buckman. Below the confluence of the Rio Puerco the valley will be subject to occasional flood discharges from this stream and from large arroyos, which may at a maximum flow discharge 15,000 second feet or more.

The construction of irrigation and drainage works will in itself confine the present flood channel, and these works will be protected at all critical points by silt retaining devices to prevent side erosion.

Silt Control

At San Marcial, the head of Elephant Butte Reservoir, an extensive river program is planned to save the town and the A. T. & S. F. Railway from flood disaster and to restore the original river grade which is plugged with silt. The removal of this silt plug will benefit the entire river through the Socorro Division.

The effect of regulating the river coupled with the retention of silt in the reservoir is certain to relieve the present tendency of the river to fill its bed. Scour will be induced in the low flood channel and the resulting lowering of the river bed will be favorable to drainage conditions.

The Rio Puerco has a watershed of over 5,000 square miles representing over 25 per cent of the Rio Grande Basin above San Acacia. This area is believed to be responsible for considerably more than one-half of the silt now entering the valley. The silt is caused by excessive erosion and deep gullying on the main stream and tributaries extending to its headwater. The erosion is of recent origin and is causing much damage within the Rio Puerco watershed. The increased rate of drainage has lowered the water table in the small valleys and ruined many acres which once produced grass and were valuable as grazing lands.

A reconnoissance survey is being made of this watershed for the purpose of studying the possibilities of reducing silt inflow in the valley and benefiting the adjacent lands by the construction of small silt retaining dams, and by inducing the growth of shrubs such as a self-seeding variety of tamarisk, for the purpose of resisting erosion.

Allocation of Costs

The New Mexico Conservancy Act is especially well adapted to the construction of an extensive and complicated project such as this, because it provides for the allocation of the cost in accordance with benefits to be received from the proposed work. Thus, public utilities and municipalities can be assessed as well as agricultural lands and city property. The proposed work will benefit all the property within the valley because of the flood protection and drainage features.

There are approximately 35,000 separate pieces of property within the district, and appraisal data is now being secured on each of these so that costs may be immediately allocated when the plan is completed.

It is impossible to estimate the cost of the project until the plan is further advanced. In a general way it is now known that the average per-acre cost for agricultural lands will be less than cost on a great many irrigation projects (raw land developments) which have been accepted for construction during recent years. The irrigation and drainage is roughly estimated at this time to cost approximately $5,000,000 exclusive of storage. While storage costs are unknown as yet, the conditions are favorable for securing effective reservoirs at reasonable cost.

The cost of engineering investigations and the preparation of the official plan is estimated at from $250,000 to $300,000. Over $100,000 of this amount has been expended.

Economic Aspect

The Middle Rio Grande Valley is located approximately in the center of the State. It is surrounded by large areas suitable only for grazing and stock raising. It is on the main line of a great trans-continental railroad and the entire area has shipping facilities easily available. Due to these facts, there is both an unusually good local market for all

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Board's Report Ends Long Controversy on San Gabriel Flood Control Project

Fowler, Marx and Paul Concur in Recommendation to Build Dam at Forks Site; Assert Engineering Advice Faulty

AT THE outset it should be stated that all of the proposed sites for flood control reservoirs on the San Gabriel River proper are above the mouth of the canyon, with tributary drainage areas varying from approximately 200 to 214 square miles.

Continuous records of the total discharge of the San Gabriel at the mouth of the canyon have been maintained by the United States Geological Survey for the 31-year period, 1895-1896 to date. The mean seasonal runoff for this 31-year period is 121,400 acre feet.

The board believes that the stream measurements cover sufficient time to represent fairly the variations of runoff that may be expected within each year, and to indicate the trend of long cycles of wet followed by long cycles of dry years. The board does not believe, however, that the record of stream measurements is of sufficient length to have included the largest probable flood discharge from the drainage area.

Distribution of Runoff

The records show that most of the runoff in each year is during the winter months. The stream is utilized chiefly for irrigation and it is an unfortunate but usual condition that the maximum irrigation demands are not in the months of maximum runoff.

It is found that 71 per cent of the runoff occurs during winter ,months during which the demand for irrigation water is only 16 per cent of the total irrigation use and 29 per cent of the runoff occurs during the remainder of the year in which the irrigation demand is 84 per cent of the total. This variation between supply and demand indicates the necessity for regulating the annual flow.

Complete Conservation Not Feasible

The erratic annual runoff together with the succession of long wet and dry periods, during which it would be necessary to store water for a period of fourteen years, renders unfeasible long holdover storage. This is especially true in view of the lack of good reservoir sites and the high cost of storage works.

Futhermore, even if the required storage capacity at moderate figures were available, it would not pay to attempt the utilization of 100 per cent of the runoff, because holdover periods are so long and evaporation losses consequently so large that storage of the entire runoff through the construction of 675,000 acre feet or more in surface storage would yield only a net annual supply of 67,000 acre feet.

On a river like the San Gabriel, where past records indicate long cycles of wet and dry years, long holdover storage in a reservoir is impracticable.

On the San Gabriel, cost of holdover storage is tremendously high and is not warranted.

Distribution of Storage

Past records show that the early runoff of flood years has always been sufficient to fill any economically justified conservation reservoir prior to the arrival of the flood. These records of large early runoff, coupled with the relatively restricted storage capacities available, are sufficient to prohibit the use of flood control capacity for the dual purpose of flood control and conservation storage. Protection from floods requires that the necessary storage space be kept empty, ready to receive a flood whenever it may come, and the prompt release of impounded flood water, so that the storage space will be available in case of another storm. It is evident therefore, that the same space in the basin cannot be safely assigned to the two uses.

Separate reservoirs for flood control and conservation offer the most ideal arrangement, but on the San Gabriel, where storage is costly, it is economy to use the same dam to create storage for both purposes. Safety in operation demands a permanent opening in the dam above the space allocated to conservation, thus preventing encroachment on flood control storage.

Existing Water Rights

Through long beneficial use, rights have been acquired to surface diversion within the canyon, at its mouth, and at the Whittier Narrows.

The surplus flow, above the surface rights at the mouth, passes over ground water basins and a relatively small proportion finds its way by percolation into underground supplies and the remainder far larger in amount than has usually been realized—wastes into the ocean.

An intensive pumping draft has been maintained on these basins and rights thereby established.

The normal surface rights would not

Editor's Note.—The following report on San Gabriel River Flood control was written and unanimously agreed to by the three members of the Board of Engineers:

F. H. Fowler, consulting engineer of San Francisco, formerly with the Federal Power Commission in California.

Charles D. Marx, emeritus professor of Civil Engineering at Stanford University, consulting engineer, chairman of the Arch Dam Test Committee, which built the experimental dam at Stevenson Creek, and at present a consulting engineer on the Colorado River project.

Charles H. Paul, of Dayton, Ohio, chief engineer of the Miami Conservancy District, and the builder of the Arrowrock Dam, erected by the United States Reclamation Service in Idaho.

The board was selected by a joint committee of the Los Angeles Chamber of Commerce and other organizations, the members of which were:

Los Angeles Chamber of Commerce—Arthur S. Bent, chairman; George I. Cochran, Harry J. Bauer, William Lacy, John W. Kemp.

The Los Angeles Clearing House—W. R. Morehouse.

Los Angeles Section, American Society of Civil Engineers—H. A. Van Norman, president; Raymond A. Hill, past-president.

Municipal League—H. L. Moller, president; Clark E. Bell, member executive committee.

California Taxpayers' Association—Joy A. Winans, chairman, Los Angeles Committee; John Lathrop, editor, The Tax Digest.

The selection of the board was prompted by a letter sent by the County Supervisors to the Chamber, asking that organization to suggest a plan to re-invest the public confidence in flood control. The Chamber responded by selecting as a committee the five named above, which committee invited co-operation by the other organizations.

A letter was sent to the Supervisors suggesting the selection by this joint committee of three eminent engineers to make an unbiased investigation, and to report to the Supervisors, such engineers to be employed by the Supervisors.

The Supervisors accepted the suggestion, the engineers were chosen, the Supervisors officially employed them. They began work on January 10, 1927, and reported on March 21, 1927.

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be harmed by a flood control reservoir, but this reservoir would modify percolation. Control of floods would reduce percolation, and it is therefore necessary to provide storage space for water that may be released after the flood, this water to be spread to compensate for reduced percolation. Studies made by the Division of Water Rights of the State of California indicate that, with some additional works, 1000 second feet could be spread. In this manner users of water from ground water basins would be protected.

Flood Problems

During the period of record, floods have caused extensive damage, and it is anticipated that the maximum flood may far exceed any of record. Proper control may be secured through a well-balanced plan for storage and channel improvement. Since storage is very expensive, it is well to carry the improvement of flood channels to the maximum.

After careful study it is believed that the maximum flood that might occur is 70,000 second feet at the Forks, and 77,500 second feet at the Mouth; this is much larger than indicated by official records during the 31-year period. This maximum flood is assumed to vary in the same manner and to have the same duration as the recorded flood of 1916. It is the opinion of the board that means should be taken to handle a second such flood within a period of two weeks.

It has been clearly demonstrated that the San Gabriel channels can safely carry a flow of 20,000 second feet at the canyon mouth, plus tributary inflow below. Therefore, the flow at the mouth has been limited to this amount in all studies. Recent floods have somewhat exceeded that flow, without serious damage, in spite of incomplete channel protection.

Conservation Storage

Studies indicate that assuming the spreading of 1000 cubic feet per second, conservation storage of 65,000 acre feet is justified. They clearly show that storage above that amount begins to have relatively less value because of the longer periods when it would be of no use, that is, when the additional space would not be filled.

The cost of additional water made available by larger storage is beyond the economic limit.

Due to the short periods during which the spreading grounds are not operative, it is deemed advisable to store an additional 5000 acre feet, giving a total of 70,000 acre feet for conservation and spreading. A reservoir of this capacity would have permitted during the past 31 years an annual waste of only 5000 acre feet; 37 per cent of this waste would have occurred during one year.

Board's Conclusions

In the following conclusions, the Consulting Board is unanimous:

1. That on the San Gabriel Project, long holdover storage is not economically feasible.
2. That the storage capacity devoted to flood control should be definitely separated from the storage capacity in the same reservoir devoted to conservation.
3. That the Granite Dyke dam site is unsuited for a dam so high as to give the required storage capacity.
4. That a reservoir for flood control and conservation in the San Gabriel Canyon should be built for a total storage capacity of 180,000 ac. ft.
5. That this capacity should be allotted as follows:
   5,000 ac. ft for Debris Storage.
   70,000 ac. ft. for Conservation and Spreading Storage.
   105,000 ac. ft. for Flood Control.
6. That to give this required capacity, a dam approximately 385 ft. high from stream bed should be built at the Forks Site.
7. That the cost of this dam and reservoir will be approximately $25,800,000.
8. That a dam at the same site storing 240,000 ac. ft. would be about 430 ft. high above stream bed, and, with the reservoir, would cost $31,000,000 or more.
9. That other units of the project, now built or contemplated, need careful replanning.
   (a) The San Dimas dam is of no use for the control of large floods and the spillway should be enlarged.
   (b) The Puddingstone spillway should be enlarged.
   (c) The Big Santa Anita dam is of doubtful value.
   (d) That plans for the Big Dalton Creek and Thompson Creek dams need revision.
   (e) The proposed dams in Eaton Canyon and in Sawpit Canyon are not economically justified.
10. That the Board of Supervisors has suffered from poor engineering advice as to a co-ordinated plan for the San Gabriel Flood Control Project.

This, in our opinion, is all the capacity it is economical to provide, and even with this capacity available, there will be many years when the reservoir will not be filled.

Debris Storage

It is apparent that any reservoir in the San Gabriel Canyon will lose a certain amount of its capacity annually, because of sedimentation. The board is of the opinion that 400 acre feet per year is ample allowance for this loss. Because of extremely high cost of storage, it seems that 5000 acre feet is as much as should be provided for this loss. Even this amount of debris storage will cost $700,000 and can afford relief for only about twelve years.

The interest on the investment for this purpose goes on piling up indefinitely, with no permanent benefit; whatever relief is gained will be only for a few years. Obviously, the larger the initial investment for such purposes as this, the more extravagant it becomes.

It is our belief that, by the intelligent use of check dams in the higher tributaries and restraining dams in the larger channels, much can be accomplished in preventing the deposition of debris in the main reservoir. From $200,000 to $250,000 could well be spent in building check dams. Restraining dams should be provided for actual silt storage and they would modify long steep grades to vertical drops, thereby reducing erosion. They could be built cheaply and with a low factor of safety.

Again it is emphasized that provision for sedimentation in a reservoir or flood control basin is a permanent expenditure for only temporary benefit, while a proper use of check dams and restraining dams gives promise of permanent protection for the money invested. If the estimate of 400 acre feet for sedimentation is correct, this means from $55,000 to $60,000 worth of storage space filled *each year* and lost forever. A yearly expenditure of more than twice that amount would be justified if some permanent cure of this evil could be achieved.

Choice of Dam Sites

The choice of a site for a large dam lay between the Forks and Granite Dyke. At the former elaborate investigation by drilling has been completed to determine its suitability. At the latter no sub-surface investigations had been made. Qualified geologists are of the opinion that while the Granite Dyke Site might be a little less desirable, either site would be acceptable geologically.

After an examination of both sites the board felt a preliminary sub-surface investigation of the Granite Dyke Site was warranted. Consequently four inspection tunnels were driven into the west abutment and diamond drilling was done in the stream bed. In none of the tunnels was rock found which was considered suitable for the foundation of a high dam. More elaborate drilling and tunneling would be necessary to determine the feasibility of a high dam at this site.

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Cost Estimate Forks Site—180,000 Acre Feet

Preliminary expense		$ 350,000	
Land and R/W 450 A @ $400		180,000	
Engineering and Supervision		450,000	
R. R. Construction—12 mi. @ $55,000		660,000	
Power lines, telephones etc.		75,000	
Contingencies		550,000	
			$ 2,265,000
Clearing Reservoir (lower part only)			50,000
Cement—2,800,000 bbl. @ $2.18 net			6,104,000
Stream Control		125,000	
Excavation—			
400,000 cy @ $1.50	$ 600,000		
550,000 cy @ 2.50	1,375,000		
55,000 cy @ 10.00	550,000		
(including cleaning and preparing for concrete)			
		2,525,000	
Spillway excavation		300,000	
Concrete—3,100,000 cy @ $2.40		7,440,000	
(not including cement and plant charges)			
Spillway concrete, copings, etc.		250,000	
Grouting, drainage, inspection galleries, contr. joint details		250,000	
Outlet works, gates, trash racks etc.		180,000	
Construction plant (less salvage)		1,800,000	
Upkeep and maintenance		675,000	
Railroad operation—60 mos. @ $4800		288,000	
Camp, warehouses, terminals, water		300,000	
Camp maintenance (net loss)		80,000	
Contractors' general expense, including superintendence, clerical, engineering, miscellaneous operations and general overhead, 3%		420,000	
Casualty and liability insurance		360,000	
Interest charges during construction (6% on $3,500,000 for 3 years average)		630,000	
Contractor's margin, including profit, flood risk, delays, contingencies (8%)		1,250,000	
Surety bond		500,000	17,379,000
TOTAL ESTIMATED COST			$25,798,000

Cost Estimate Forks Site—240,000 Acre Feet

To determine the additional cost of a dam to store the 240,000 acre feet as contemplated by the Flood Control District, the following estimate is given. This is based on a design similar to the one recommended for the 180,000 acre foot reservoir capacity and is predicated on the assumption that the flood ports will be placed at the bottom of the flood control portion of the basin and that they will be left open permanently. Otherwise, the spillway capacity and the character of the protection required would be materially changed, and at least $500,000 would be added to the probable cost of the structure, to cover such changes.

Preliminary expense		$ 350,000	
Land and R/W 500 A. @ $400		200,000	
Engineering and supervision		500,000	
R. R. Construction—12 mi. @ $55,000		660,000	
Power lines, telephones etc.		75,000	
Contingencies		600,000	
			$ 2,385,000
Clearing Reservoir (lower part only)			50,000
Cement—3,600,000 bbl. @ $2.18 net			7,848,000
Stream Control		150,000	
Excavation—			
450,000 cy @ $1.50	$ 675,000		
600,000 cy @ 2.50	1,500,000		
60,000 cy @ 10.00	600,000		
(including cleaning and preparing for concrete)			
		2,775,000	
Spillway excavation		200,000	
Concrete—4,000,000 cy @ $2.40		9,600,000	
(not including cement and plant charges)			
Spillway concrete, copings, etc.		250,000	
Grouting, drainage, inspection galleries, contr. joint details		300,000	
Outlet works, gates, trash racks		200,000	
Construction plant (less salvage)		2,000,000	
Upkeep and maintenance		750,000	
Railroad operations—66 mos. @ $5000		330,000	
Camp, warehouses, terminals, water		350,000	
Camp maintenance (net loss)		100,000	
Contractors' general expense, including superintendence, clerical, engineering, miscellaneous operations and general overhead, (3%)		510,000	
Casualty and liability insurance		450,000	
Interest charges during construction (6% on $4,000,000 for 3 years average)		720,000	
Contractor's margin, including profit, flood risk, delays, contingencies (8%)		1,495,000	
Surety bond		600,000	20,780,000
TOTAL ESTIMATED COST			$31,063,000

The board, after rough estimates considering the slight saving in cost and extra hazards at the Granite Dyke Site, has no hesitation in eliminating this site.

Two tunnels were driven into the west abutment of the Forks Site. Rock of fairly good quality was found in both at a distance of from 40 to 50 feet. As a result, the Forks Site for the San Gabriel Dam is approved.

To arrive at the flood control storage required the estimated maximum flood of 70,000 cubic feet per second was assumed to enter the Forks Reservoir at a time when the entire conservation and debris storage of 75,000 acre feet was completely filled. Permanently opened flood ports, designed to limit the maximum discharge to 14,000 second feet, passed a portion of the flood while the remainder was stored in the reservoir. The flood control storage necessary to control the flood flow in excess of the capacity of the ports, was found to be 105,000 acre feet. The release of 14,000 second feet at the Forks, plus the runoff between the Forks and the Mouth, gives a controlled peak flow at the Mouth of 20,000 second feet; the estimated safe flow.

RECOMMENDED STORAGE

Debris Storage	5,000 acre feet
Conservation and Spreading	70,000 acre feet
Flood Control	105,000 acre feet
Total	180,000 acre feet

A dam at the Forks site to give this reservoir capacity (elevation of water surface 1728) would have a maximum height of about 450 feet above foundation, or 385 feet above the present stream bed.

We recommend outlet capacity of 1000 second feet under 20 foot head, at about elevation 1400, for emptying reservoir and sluicing purposes. Outlet capacity of 2000 second feet under 20 foot head, at about elevation 1450 (duplicate banks of 1000 second feet capacity each), and flood ports, with no gates, of 14,000 second feet maximum capacity with inverts at elevation 1615. These flood ports will be more efficient if designed with horseshoe-shaped cross-section. With oulets so laid out, the spillway would be required only as an added factor of safety, and its capacity might safely be limited to say 5000 second feet.

The design of the cross section of the San Gabriel dam has already been given careful study by the flood control engineers. The adopted design, known as the "R" section, is applicable to the lesser height which conforms to our recommendations and meets with our entire approval. This design has already been the subject of analysis and report by Messrs. Henny and Galloway, as covered by their report dated August 24, 1925.

Further detail of the design of the dam as a whole, with appurtenant structures, are given in contract drawings accompanying "Contract and Specifications for San Gabriel Dam," furnished to us by the chief engineer. This design is for a much larger reservoir than we are recommending, and consequently, for a higher dam with a heavier maximum cross section. Evidently a method of operation is contemplated very different from that recommended here, because there are no permanently open flood ports and obviously it is intended to allow a large portion of a maximum flood to pass over the spillway. For such purposes the spillway design, shown on the drawings is entirely inadequate. Reason-

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able safety measures would require spillway protection of entirely different character and of much greater cost. The 2000 cubic yards of concrete paving in the schedule of quantities accompanying the contract and specifications would hardly make a start on what would be required. Moreover, the large quantity of spillway excavation that would be required is not included in the schedule of quantities. Should a dam ever be built as provided by these specifications, a very careful re-design of spillway should be made, and large amounts would have to be added to the schedule of quantities to provide for spillway excavation and spillway concrete.

Cost Estimates

These cost estimates are somewhat higher than those which have been made by the Flood Control District, and for that reason have been subjected to repeated review and scrutiny. They have been carefully prepared after a review of the experience on some of the large dams that have been built during the last few years, after a thorough study of as many relevant cost records as are available, and after consulting other reliable sources of information.

Where estimated quantities are used, they have been computed from the best data available, including tunnel explorations and careful study of drilling records and cores at the site. Unit prices have been estimated with care, and proper allowance has been made for contractor's plant, camps, plant maintenance, camp operation, interest charges, insurance, hazards of the job, contractor's profit, etc., all of which will be included in the bid of any responsible contractor. In the opinion of the board, these estimates show approximately what will be required to entirely complete the work.

This estimate is based on a flood control plan as recommended in this Report. Should the flood control space in the basin be used also for conservation storage, a larger expenditure for spillway construction would be required.

Other Units of Project Need Replanning

As to the other units of the San Gabriel Flood Control Project which are in various stages of completion, there is urgent need of careful replanning. Very large sums have already been spent on these works and other large expenditures are being made and are contemplated. The board is convinced that ordinary engineering and economic principles have not been applied to the planning of the various units of the project in advance of their construction. The dams have been well designed structurally, and are being well built, but the flood control capacity provided bears no relation to the maximum runoff to be expected from the drainage areas. The economics of conservation storage seem to have been ignored. There is no definite program for the operation of the dams except to let the basins fill whenever they will and then to take chances on handling the floods through the spillways. It is apparent from the designs of the dams and the methods of operation that have already been adopted, that the flood control feature of the project has been largely or wholly subordinated to the conservation feature, and that the dams already built are being used almost solely for conservation, and, therefore, are of practically no use for flood control.

The experience at the San Dimas Dam during the storm of February, 1927, is an example. The drainage area above this dam is seventeen square miles, from which a flood may be expected with a maximum daily runoff as large as 11,000 acre feet. The storage capacity behind this dam, to spillway elevation, is less than 1500 acre feet. There is a maximum outlet capacity of 2250 second feet under full head, and a spillway capacity of 2200 second feet. Any *large* storm would fill this basin in only a few hours, even with the outlets wide open, after which the spillway, running at full capacity, would not handle the surplus water.

In spite of this, the San Dimas reservoir was permitted to fill as soon as possible during the recent storm, and water was running over the spillway before the rain stopped. The outlet gates were not opened at all until the reservoir was practically full. In other words, there was no attempt whatever to operate the San Dimas reservoir for flood control.

The point is, that it should be decided in advance of design whether a reservoir is to be used primarily for conservation purposes, or for flood control. Upon such decision depends to a great extent, the capacity of basin required, as well as the size, location and type of outlets, and the type and capacity of spillway. It is a direct violation of sound engineering to design for one purpose and assume that the structure will function for both.

San Dimas Dam

The storm of February, 1927, was not a large one compared with what may be expected. No human mind can tell in advance when a rain is going to stop. Another few hours of heavy rain during the February storm would have found the San Dimas reservoir completely filled and entirely useless as far as flood control is concerned. In fact, not only is it of no use for the control of large floods, but, in case of a flood approaching the maximum, it is very likely to be a menace to the property below. A flood peak much smaller than the maximum to be expected, coming down on a full reservoir, would exceed the capacity of the spillway, and overtop the dam.

The proposed canal of 5,000 second feet capacity from San Dimas dam to Puddingstone Reservoir, is said to have for its purpose the diversion of surplus flow from the San Dimas Reservoir to one of larger capacity. With only 2,250 second feet capacity in the San Dimas outlets, the proposed canal seems to be much larger than can be used. Even with the spillway operating to full capacity, the canal would not be filled, and whenever the spillway is so operating, a most serious condition exists. Moreover, if this method of handling flood waters is contemplated, all that is required at the San Dimas site would be a diversion dam, which would be much cheaper and safer. The only possible reason for a dam such as is built at San Dimas is for strictly conservation purposes. To make it safe for such use, a large increase in spillway capacity is required. Also, a flood channel should be provided down the San Dimas Wash. Otherwise, a large flood (which cannot be controlled) may do heavy damage to property.

Puddingstone Spillway Inadequate

The Puddingstone reservoir has a drainage area of 36 square miles, including that above San Dimas. It has already been shown that the effect of the San Dimas dam in controlling a maximum flood is negligible. Assuming that the diversion canal will be built, a flood may be expected into the Puddingstone from this drainage area with a maximum daily runoff of not less than 20,000 acre feet. Such a runoff coming into an empty reservoir could be handled without danger of overtopping the dam, but should such a flood find the Puddingstone reservoir filled or nearly so, the combined capacity of outlets and spillways would be exceeded and this earth dam would be overtopped. There is danger of this even should the diversion canal not be built. Overtopping should not be permitted under the circumstances, and, therefore, a re-design of the spillway of the Puddingstone dam is imperatively necessary. Otherwise the dam will not be safe.

Santa Anita Dam of Doubtful Value

The Santa Anita dam, with a drainage area of 11 square miles behind it, provides a storage capacity of 1,530 acre feet. The combined capacity of outlets and spillway is 3,870 second feet. A flood with a maximum daily runoff of 8,000 acre feet (which corresponds to an average daily flow of 4,000 second feet), is not too large to expect from this drainage area, but should such a flood occur, the capacity of outlets and spillways would be taxed to the limit. The effect

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Owyhee—Vale Project Is Big Boost for Eastern Oregon and Southwestern Idaho

Government Will Provide 168,000 Acres of Selected Land With Dependable Water Supply at Cost of $21,000,000

By HAROLD M. SIMS

UNCLE SAM is rolling up his shirt sleeves preparatory to tackling another big job of reclamation. The fact that there has been some over-production in agricultural lines during the last few years has not served to distract Uncle Sam's attention from the census figures. These show that this nation cannot keep on growing at the rate of 2,000,000 persons a year and remain a self-supporting nation without more farms.

Farms cannot be created out of desert wastes over night, and against the day when more farms will be direly needed Uncle Sam proposes to provide more than 2000 farms in eastern Oregon and southwestern Idaho.

Tentative cost estimates already exceed $21,000,000. Approximately 168,000 acres of carefully selected land is to be provided with a dependable and adequate supply of water. The reservoir will have a storage capacity of 600,000 acre-feet of water.

High Dam Planned

One of the highest dams in the United States is to be built. It will be 360 feet high, 600 feet across the top and is to contain 405,000 cubic yards of concrete.

Other outstanding features of the undertaking are a diversion tunnel 3½ miles long and 15 feet in diameter, five miles of tunnel 10 feet in diameter, a steel siphon 2½ miles long and nearly 200 miles of supply canals.

The government is killing a whole flock of birds with one stone in its new undertaking. In addition to reclaiming 105,000 acres of arid lands it will afford relief to seven existing pumping projects, embracing some 50,000 acres, by providing a gravity flow and thus relieving these projects of what has proven to be virtually prohibitive operation charges; it also provides a supplementary water supply for another existing project of 13,000 acres that at present has only a partial water right, and through the purchase of a high interest in the reservoir of still another project provides funds for a needed drainage system for its lands.

The undertaking is of a dual nature—the larger section, the Owyhee project, including an area of 139,560 acres, about 60 miles long and from five to ten miles wide, along both sides of the Owyhee and Malheur rivers and along the west side of the Snake river. The other project, the Vale project, is practically adjacent, farther up the Malheur valley, and embraces 38,560 acres.

Tax Rolls to Gain

These two projects, it is estimated, will add nearly $50,000,000 to the tax rolls of the state and increase the population of the state by some 25,000.

All of the land embraced in the two projects is within a few miles of thriving towns. Some of it adjoins farm land that is already improved, and most of it is within a short distance of improved highways.

The water supply will come from the Owyhee river, which has an annual run-off varying from 298,000 to 2,309,000 acre-feet, with an average of more than 1,000,000 acre-feet annually over a 23-year period.

Requirements for the lands to be irrigated are estimated at 600,000 acre-feet annually, and can be met fully in most years with the aid of the 600,000 acre-feet of storage capacity of the proposed reservoir. Plans provide for the delivery of 3¼ acre-feet of water for every acre of land.

The dam is to be built in a canyon section of the Owyhee river about 20 miles above where it empties into the Snake. A natural reservoir is formed by the typography of the country, as is seen from its picturesque name, that part of the canyon having been designated many years ago "Hole-in-the-Ground." Its height from foundation to parapets will be 360 feet. The capacity of the reservoir will be more than double that of the great Arrow Rock dam of the government's above Boise, Idaho.

Railroad Planned

A railway connecting with the Homedale branch of the Union Pacific is to be built from a point near Nyssa to the dam site, a distance of about 20 miles, to haul material for the dam. It is estimated that approximately 100,000 tons of material will be required—about 2000 carloads. The survey for the railroad is just being completed, and bids are to be asked for its construction in the near future, this being the first step toward actual construction.

It is proposed to raise the water level behind the dam 304 feet. The diversion tunnel will be 234 feet above the river bed, so that only the upper 70 feet of water will be available for irrigation. This will provide an available storage capacity of approximately 600,000 acre-feet.

The lower portion of the reservoir will be "dead" capacity, it being necessary to divert the water at a high level in order to get proper elevation for distribution.

Provision will be made for releasing water through the dam for the Owyhee ditch, an existing gravity canal system that diverts water from the Owyhee river several miles below the proposed dam. The Owyhee ditch at present provides a partial water right for some 13,000 acres of land in Oregon, along the west side of the Snake river, south of Ontario. The Hole-in-theGround reservoir will provide a supplemental storage for this 13,000 acres and thus assure an adequate supply throughout the entire irrigation season.

Tunnel to Carry Water

Water is to be drawn from the reservoir for the new project through a diversion tunnnel 3½ miles long and 15 feet in diameter. The tunnel will extend in a northeasterly direction, which is the same general direction in which the river flows.

At the end of the diversion tunnel will be the headgates of the distribution system. Some of the water will be turned south through another tunnel nearly five miles long and more than ten feet in diameter to supply by gravity approximately 42,000 acres in and above the Gem irrigation district, replacing the costly pumping system of the latter and thus relieving the 25,000 acres comprising one of Idaho's distressed projects of its virtually prohibitive operation costs.

From the end of the main diversion tunnel a main canal will continue in a northerly direction about four miles, still paralleling the general direction of the river. Here this canal will fork, one division dropping eastward to supply the Kingman divison of the project and the other swinging westward across the Owyhee river to supply the Mitchell butte and Dead Ox flat divisions of the project and to substitute gravity flow for the pumping system of the Payette-Ore-

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gon slope slide and other irrigation districts, thereby relieving them of the present excessive operation costs.

The four miles of main canal will comprise 1½ miles of earth canal with a bottom width of 30 feet and depth of 10 feet, 1500 feet of concrete-lined tunnels, 300 feet of concrete siphon, 900 feet high-head steel siphon, 8700 feet of concrete flume with a width of 17 feet and depth of 11½ feet and the remainder of the four miles will be concrete lined.

Other Projects to Gain

The Gem irrigation district and adjacent lands, situated principally in Idaho, will be watered from a canal 68 miles in length, extending in a southeasterly direction from the outlet of the five-mile tunnel. This canal virtually parallels the Snake river for a distance of about 30 miles and provides for the irrigation of the strip of land between the canal and the river. This strip varies in width from two to eight miles, the main body being about six miles wide. This main body includes the Gem irrigation district, which at present is being irrigated by two pumping plants which lift water from the Snake river. Homedale is the trading center of this region, which is served by a branch of the Union Pacific.

The government canals will be farther up on the bench than the pumping plant canals, and will provide for the reclamation of the arid lands between the new government canal and the irrigation district's canals, as well as for a substantial body of land farther south.

One interesting feature of this part of the project, which will be readily observed by reference to the map, is that while the government canal will extend in the same general direction as the pumping plant canals, the water in the two canals will flow in opposite directions. The pumping plants will be abandoned and water turned into the Gem districts system from the new government canal.

The Kingman division lies along the Owyhee river between the end of the main canal and the Snake river. It is an unreclaimed body of land, with the exception of a comparatively small acreage irrigated by the Kingman colony pumping project. The Kingman canal will be eight miles long, and will have 1500 feet of lined sections, bench flumes and siphons.

Mitchell Butte Division

The Mitchell butte division is the principal body of unreclaimed land in the project. It lies on the Oregon side of the Snake river, above the Owyhee ditch and between the Owyhee and the Malheur rivers, which are about 18 miles apart. This body of land lies somewhat in the shape of a "U," and includes slopes and bench land in three valleys, the Owyhee, Snake and Malheur.

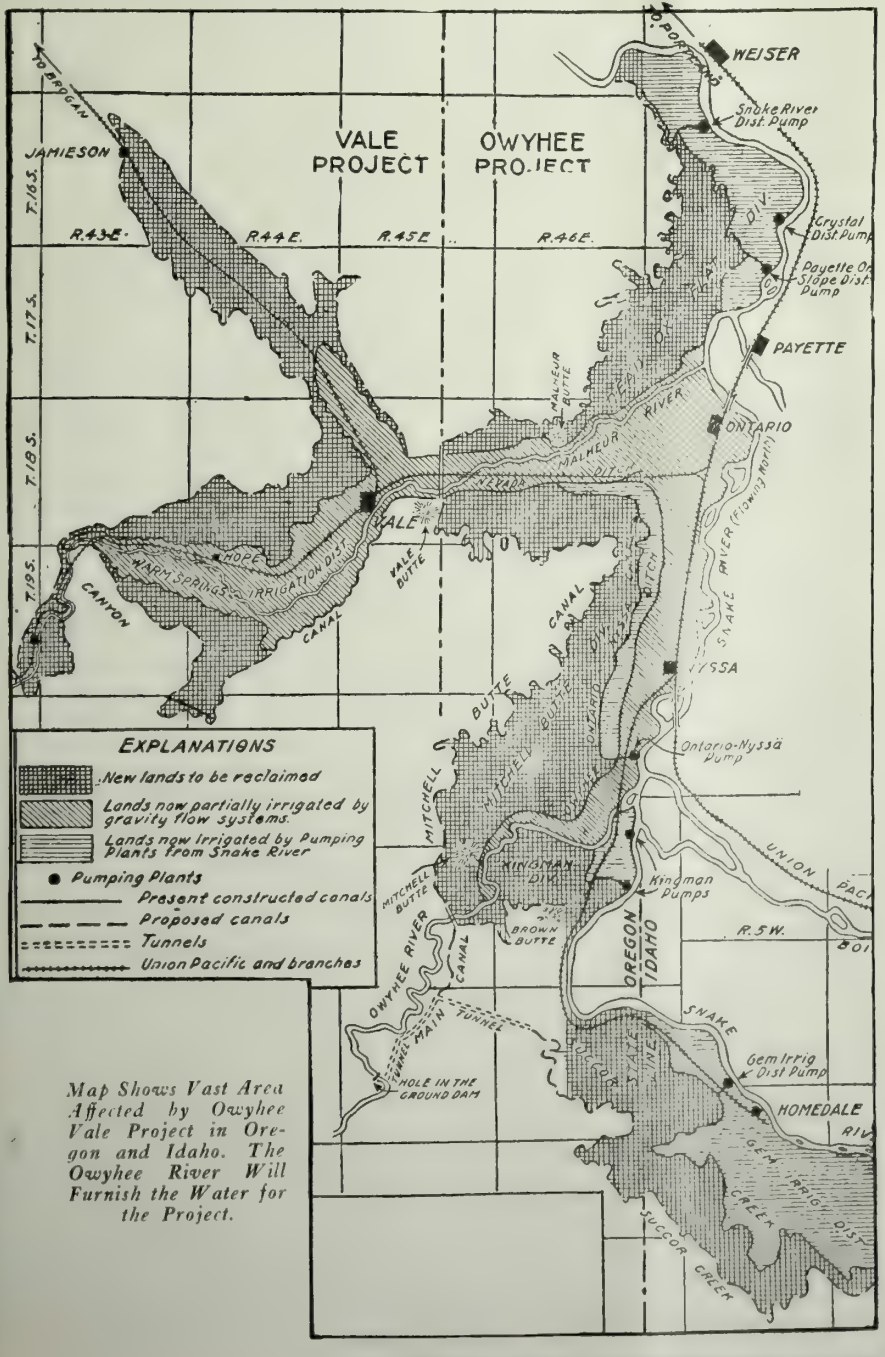
The Dead Ox flat division of the project extends along the north slope of the Malheur valley to a point near Vale, Oregon, along the western bench of the Snake river valley almost to Weiser, Idaho. This body of land also is wholly in Oregon. It approaches to within 3 miles of Ontario, on the Oregon side, and within about the same distance of Payette, on the Idaho side. Between the new lands to be reclaimed and the Snake river are several pumping projects, which, with the completion of the government canal, can abandon the costly process of lifting water from the Snake river and irrigate with a gravity flow. The Payette-Oregon slope irrigation district is the largest of these pumping projects.

The Mitchell butte and Dead Ox flat division of the project are served by the main line of the Union Pacific and by the Vale branch running up the Malheur valley.

Vale Project

The Vale project, embracing some 28,000 acres, would be virtually an extension of the Owyhee project farther up the Malheur valley were it not for the fact that it will be supplied with water from another source. For the irrigation of this section the government has contracted to buy a half interest in the Warm Springs reservoir, on the middle

(Continued on Page 41)



Map Shows Vast Area Affected by Owyhee Vale Project in Oregon and Idaho. The Owyhee River Will Furnish the Water for the Project.

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The EDITORIAL

MODERN Irrigation

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RUSSELL R. PALMER
Editor

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Vol. III APRIL, 1927 No. 4

An Announcement

THROUGHOUT the United States, and especially the West, hundreds of millions of dollars are being spent on giant dams and auxiliary works that *must* be built to keep pace with the growth of this nation and the ever-increasing demands on its water resources. In close touch, as it is, with this trend in water development and appreciating the interest of its readers in the vast undertakings that are assuming form from month to month, MODERN IRRIGATION proposes to devote an entire issue to *hydraulic dams* and within a few weeks will publish its FIRST ANNUAL HYDRAULIC DAM NUMBER.

It is hardly necessary to point out, particularly to engineers whose daily work brings them in close touch with dam construction, that the money being spent, and to be spent, on these vast water conservation projects runs into the hundreds of millions of dollars. For instance: Thirty millions (of which $25,000,000 have already been appropriated) will be spent in the building of the great San Gabriel Dam of Los Angeles County, California. Twelve similar structures are actually under way or projected for Los Angeles County alone. And many millions more will be spent in the building of the Coolidge Dam in Arizona—builders' plans for which appeared in a recent number of this journal—the Owyhee Dam in Washington—described in this issue—the San Joaquin River Storage Dam, Lake Cle Elum Dam, the Ruby Creek Dams of the City of Seattle, Big Tejunga Dam, and other great hydraulic structures of the United States; not to mention the $30,000,000 construction program of the Mexican government's Reclamation Bureau, and innumerable other projects in foreign and domestic fields.

Then, too, the proposed Boulder Dam on the Colorado River will cost in the neighborhood of $50,000,000, exclusive of the great subprojects composing auxiliary construction, which will bring the cost of this entire project to about $200,000,000. And this does not include the cost of the Los Angeles aqueduct to the Colorado, which will cost in the neighborhood of $200,000,000 more.

OBVIOUSLY, this is a big subject, a subject of the greatest moment to hydraulic engineers the world over. MODERN IRRIGATION, we believe, could hardly keep faith with its readers, who look to this journal for the news and the recent engineering developments in the field of hydraulics, were it not, at least once a year, to devote more space to dam development than is possible in an ordinary single issue of the publication. As a matter of fact, the more time and thought the editors of the journal devote to this special number—and they have been at it now for nearly a year—the more is the realization brought home to them that this tremendous expansion of the irrigation, hydro-electric and municipal waterworks industries is something that it will tax their ingenuity to confine within the covers of any one issue of the journal; but by making the hydraulic dam number an *annual feature* they hope to be able to record in practical, usable form for the engineer the details of this great development of modern America.

The forthcoming hydraulic dam number will be the very next thing to a text and reference book on the subject of dams, their design and construction. Its contents will have a direct, practical appeal to every hydraulic, consulting and operating engineer in the country, as well as to every contractor doing work in the hydraulic field. Space limitations forbid a detailed outline of the editorial contents, but the whole will resemble a veritable encyclopedia of practical information on every phase of dam construction and will include, as well, a general catalog of equipment and a buyers' guide to the leading supply sources, a feature of particular value to both engineer and contractor. Our one purpose is to make this annual number an outstanding contribution to the practical literature of water development.

The Forests and Our Water

THE WEEK of April 24-30 has been set apart by President Coolidge as American Forest Week "in the belief that no other of our internal problems is of greater moment than the rehabilitation of our forests." Special significance is attached to the observance of the

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POINT *Of* VIEW

week in 1927 in view of the disastrous fire season through which the country passed last summer and of the need for bringing home to the people of the nation the necessity for adequate protection of the forests.

The economic interest of the American people in their forests everywhere, but particularly in the West, is to preserve the water-holding power of the mountain watersheds of the country. The mountains covered with trees and brush are the natural and best conservers of water, but denuded, are a dangerous factor.

In the West, and especially in Southern California, we are ever mindful of two great problems—flood control, and the conservation of water. We build mighty dams to check the rushing flood waters in their disastrous course, and to form huge storage reservoirs; we struggle against the ever-increasing silt that accumulates in these reservoirs and lessens their holding capacity; but we do not give sufficient thought to the fact that the forests are important conservers of water, that they do much to regulate the run-off, and that through their prevention of soil erosion they can do more than any other one thing to check the accumulation of silt in reservoirs.

The capacity of the earth to receive and convey water is all-important to us. The porous rocks, gravels, and soils of the earth are a time-tried storage beside which the largest surface reservoirs are small affairs. All soils are dependent upon their top surface as to whether or not they will get any water to absorb. The soil in a brush-covered area is soft and spongy with humus which permits the water to seep in and can thus take care of a much greater rainfall than a burned over forest in which much of the humus has been destroyed.

Storm run-off is that part of the rainfall which flows from the surface of the watershed after the upper soil has become saturated and can absorb no more water. If the surface of the watershed is denuded of timber and underbrush, the storm run-off will be largely increased over that from a well-timbered watershed where trees and undergrowth form a resistance to the run-off and retain the water longer upon the surface, giving it more time to penetrate into the pores of the earth and subsequently into the subterranean channels and reservoirs which retain their water and give it up gradually during the summer into the streams or artesian supplies of the valleys.

A bare mountain watershed with any rainfall must produce torrents, and the steeper and more extensive these mountains are, the more dangerous and destructive will be its torrents. Complete denudation of a mountain watershed means, with absolute certainty, the creation of torrent action. In Southern California it is especially necessary to take action to prevent these torrents because of the topography of the country, with its series of Sierras, and because of the climate, with its long dry season.

Because these torrents are violent and of large volume, and owing to the fact that the soil of the drainage basins is not held together by a network of roots, extensive erosions occur in these barren basins and the water carries much silt in suspension. Each rain washes away tons upon tons of loam, sand and rock to cover up the fertile soil of the lower lands and to fill up the reservoirs that have been created, thus diminishing their capacity.

Fire is the greatest single enemy of the forests. Each year a line of fire 33,000 miles long and two-thirds of a mile wide eats its scarlet way through our woodlands. According to statements from the U. S. Forest Service, we have averaged 51,000 forest fires annually in the United States during the past ten years. These fires have swept on an average of 11,800,000 acres of forest land each year. The outstanding fact about forest fires is that ninety per cent of them are man caused. When the American people stop burning their wooded areas, the problems of flood control, erosion, and constantly decreasing water supply will be at least partly solved.

A New Feature

IN DEVELOPING its editorial contacts throughout the western states MODERN IRRIGATION is in constant touch with correspondents who give the journal advance information on numerous construction programs for city waterworks, sanitary and sewage disposal plants, irrigation projects and pipe lines for all classes of hydraulic work. In order that the readers of the magazine may have access to this mass of information and in many instances profit by it in a practical way it is our purpose, beginning with this issue, to devote a department of the publication to such information, classifying it according to the nature of the contemplated work rather than territorially. Each paragraph will carry some pertinent information on contemplated work in the western states.

In beginning this new feature we are aware that it is hardly within the province of a monthly magazine to act as a daily or weekly news organ. We fully appreciate that a few items may lose some of their practical value before we can get them into print; that is, they will not reach the builder, contractor and equipment manufacturer in time to enable him to take full advantage of them. But any such subscriber can, if he wishes, make arrangements with the editors of the magazine to secure information of particular interest to him as soon as it reaches this office. Most of the items published will retain their *full* value until after the magazine reaches the reader and every item will be of interest to the reader who desires to keep informed of the trend of water development in the western states. Suggestions or criticisms of the new department will be gladly received.

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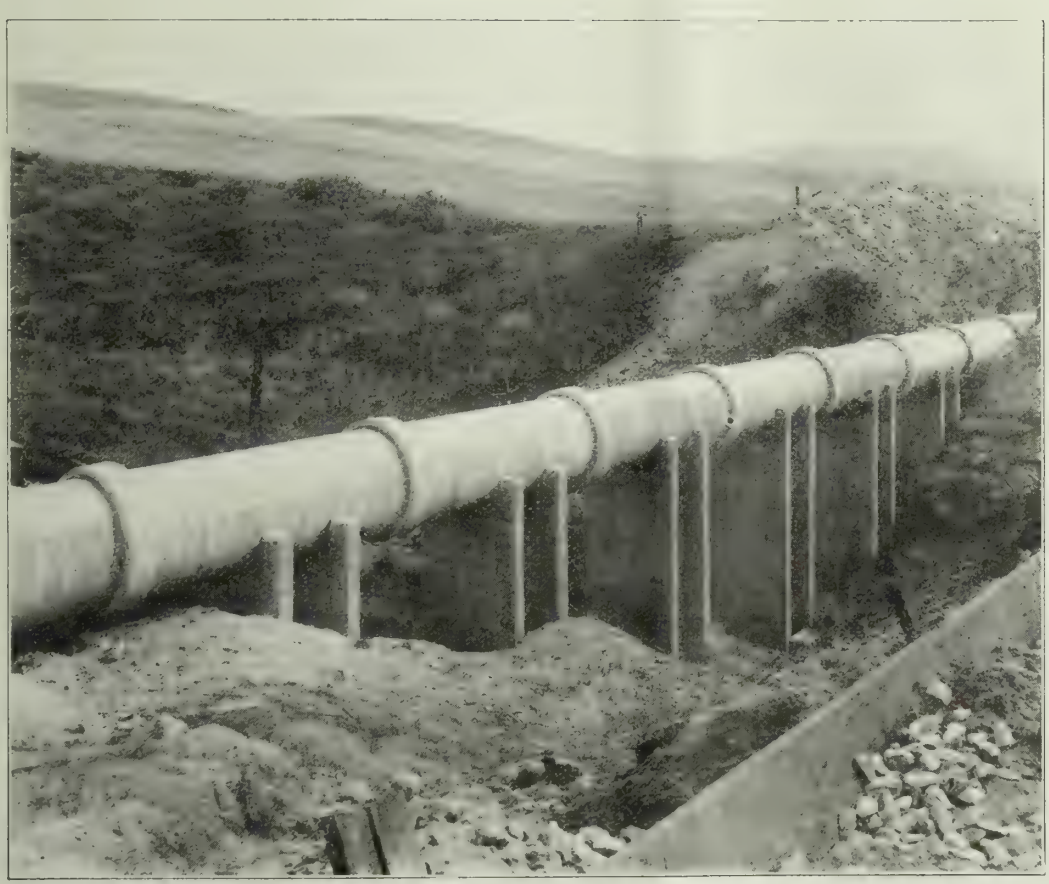

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Edward C. Murphy Retires

The first engineer of the Water Resources Branch of the United States Geological Survey to be retired under the act for the retirement of employees in the classified civil service is Edward C. Murphy. With his retirement there passes from active service one who has contributed much to the engineering profession, especially to hydrology.

Mr. Murphy was born in Canada June 19, 1859, and graduated from Cornell University in 1884 with the degree of B.C.E. He also holds the degrees of M.S. and Ph. D. from the same university. In 1885 and 1886 he was a fellow in mathematics at Cornell; from 1887 to 1898 he was assistant professor of civil engineering at the University of Kansas; and in 1899 he returned to Cornell as a fellow in civil engineering.

Mr. Murphy was connected with the Geological Survey intermittently from 1892 to 1902 and continuously from 1902 until October 16, 1926. From 1892 to 1898 he was resident hydrographer in eastern Kansas. From 1898 until he began full-time service he did special investigational work.

He is especially known for his early papers on windmills and on the accuracy of stream measurement by means of the current meter. In 1906 he moved to California to assist the late Dr. G. K. Gilbert in his studies on the transporting power of rivers, and by his painstaking work he contributed largely to the success of that important investigation, which was given to the public in Professional Papers 86 and 105. In addition to his reports published by the Government, he has contributed generously to current engineering literature.

W. I. E. A. Meets at Fresno

The regular quarterly meeting of the Western Irrigation Equipment Association was held at Fresno, California, April 15. A. M. "Jack" Frost, manager of sales of the San Joaquin Light and Power Corporation, was master of ceremonies.

The morning session was given over to the meeting of the association officers, and a general business meeting followed in the afternoon, beginning at 2 o'clock, in the auditorium of the San Joaquin Power Building.

The evening session took the form of a dinner at the Fresno Hotel. Through the courtesy of the San Joaquin Light and Power Corporation, a new moving picture was shown, entitled "The Carpet of Green," which pictured the story of the new San Joaquin power plant of the Balch project. Al C. Joy, manager of the publicity department of the San Joaquin Corporation was the principal speaker of the evening.

San Francisco O. K's. Vote

The San Francisco board of supervisors on March 21 gave their approval to a bond election for $40,000,000 for the purchase of the Spring Valley Water Company's system. The date for the bond election has not been definitely set, but it is thought that it will be some time in June. The supervisors also adopted a resolution declaring that the water system should be placed under the jurisdiction of a Public Utilities Commission "to have charge and control of the operation, maintenance and conduct of all the properties acquired from the Spring Valley Water Company." An amendment to the city charter will be submitted providing for the creation of such a commission.

Vote Water Bonds 3 to 1

Baldwin Park, California, voted almost three to one for water bonds at the special election held on March 24. The proposition called for a bond issue of $225,000 for the purchase of the present water plants and equipment of the Baldwin Park Domestic Water Corporation, so that the newly formed Baldwin Park County Water District could own and operate its own water plants for supplying its citizens with both irrigation and domestic water at lower rates than paid at present. The total vote was 432 for and 146 against bonds.

Salt River Has Huge Storage

The Salt River Valley Water Users' Association reports a daily gain in water storage of approximately 3500 acre feet. On March 20 a total of 752,000 acre feet was impounded by the Roosevelt and Mormon Flat reservoirs, a greater amount than at any corresponding period since 1922.

Fire Destroys Warehouse

The Imperial Irrigation district warehouse at Andrade, California, was completely destroyed in March by a fire which is believed to have originated from defective electric wires in the building. The damage is roughly estimated at about $65,000, most of which was covered by insurance.

Glendale Completes Reservoir

The city council of Glendale, California, has accepted the Chevy Chase reservoir, the newest part of the city water system. It is of concrete construction and has a wooden top. The total capacity is 15,000,000 gallons.

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WESTERN Waterworks
Supplement to Modern Irrigation
Of Interest Expressly to Waterworks Executives, Contractors, and Municipal Engineers

Recent Developments in Water Purification Methods Reveal Accuracy of Prophecies

By C. ARTHUR BROWN
Chief Engineer, Engineering Bureau, Water Purification, American Steel and Wire Company

ELEVEN years ago, approximately, we were asked to prepare a paper for the Southwest Water Works Association and did so, under the above title. That a paper under this same title is now requested seems to indicate a desire for a follow-up of the original. Without abstracting this old paper, we may say that in a general way it has proven a fairly good prophecy.

Water purification, as an art, may be said to divide, naturally, into several parts, as follows:

1. Initial, or low lift pumping.
2. Preliminary sedimentation.
3. Chemical treatment.
4. Mixing.
5. Sedimentation.
6. Filtration.
7. Sterilization.

A brief survey of these seven divisions with outlook to the future development probably to be looked for, will constitute the essential features of this paper.

Initial Lift

Little change in practice is to be seen or expected except in the substitution of electrical power for steam in a good many plants during the last ten years. The trend is apparently rather strong in this direction and may be expected to go farther. Better and more efficient pumps have been developed for this work and improvements in this same direction will probably continue for a number of years to come.

More and more plants are being designed with preliminary settling reservoirs. The capacity of these may vary from a few hours to several days detention time period. A few of the larger size provide for several months detention.

THE accompanying paper by C. Arthur Brown was presented at the Texas Waterworks School in January, and through the courtesy of the American Steel & Wire Company, Modern Irrigation was given the privilege of presenting it to its readers. Inasmuch as Mr. Brown's treatment of the subject is quite exhaustive, covering every phase of water purification, the paper is being published in two parts. The second part, dealing more particularly with filtration, and various methods of sedimentation, including filter processes and equipment, will appear in an early issue.—Editor.

Generally speaking, every plant would function better and considerable operating difficulty would be eliminated by providing such basins, assuming that they are used intelligently, their equipment being such to permit it.

It is pleasing to note that engineers are paying more attention to this feature of design and that some are now arranged so that they can be entirely by-passed, should occasion demand. This is a step in the right direction but it does not go far enough. Some plants have been designed with yet another betterment. These plans have contemplated basins so arranged that various compartments or combinations of compartments can be employed as necessity demands. To actually by-pass the preliminary settling basins usually involves more operating difficulty than is desirable.

While these basins may be used a great deal of the time and almost all the time in a few plants, there comes a time in the operation of nearly every plant when it could be operated to better advantage on very short detention periods in these basins. In some plants a long detention period in these basins has a tendency to increase, rather than to decrease operating difficulties.

Miscroscopic Organisms No Trouble

Microscopic organisms, growing on the bottom of our rivers, lakes and ponds, classed generally as benthos, do not give us much trouble. When they are found in water, the turbidity is generally so large that it constitutes the difficulty and in removing it the micro-organisms are removed with no trouble. With plankton, however, the case is different.

These floating micro-organisms usually occur when the turbidity is very low and the water relatively clear. They are not readily handled by any coagulation process now in use, although softening plants, either commercial or municipal, are seldom annoyed by them. In fact, so far as our memory goes, we have never heard a complaint from one.

When plankton are present in sufficient quantities to cause trouble around the plant, the use of a preliminary set-

tling basin does not tend to make matters any better, as a long detention period in such basins only permits additional growth of the number of such organisms, which is not desirable.

At such times it is well to be able to reduce the detention time period in such basins to a minimum and still permit the plant to be operated under the more or less constant head pressure which is obtained by the use of the preliminary settling basins. These basins should, therefore, produce a fairly constant head or pressure to create flow into the plant proper at all times and during times of high turbidity they should be of material assistance in decreasing the turbidity and throwing the heavier matters out of suspension, while during the weeks or months during which trouble from micro-organisms is being experienced, the basins should not add to the difficulty by forming a place where the trouble breeders can multiply and increase in number.

We believe the trend in this case is to provide more and better equipped preliminary settling basins and that this will continue for some time to come.

Chemical Treatment

Under this we have again to divide as follows:

1. Measurement of flow to be treated.
2. Control of flow previous to, during and following treatment, including formation of coagulation and introduction of water into the settling basins.
3. Nature of chemical treatment to be given.

The trend is very conclusively towards such measurement. More and more plants, even old ones, are being provided with meters to measure the flow of water into the plant. This is as it should be; the measurement is a real necessity to enable the operator to conduct the chemical treatment in an intelligent manner, it being obvious that a proper treatment cannot be given unless it can be known what the volume of flow is that requires treatment.

It is pleasing to note the advance in this particular phase, as the measurement has other advantages in addition to that of enabling the operator to treat the supply as he desires. However, a word of caution in this matter is not out of place.

In some designs recently made this is carried too far, at least in a way. The trouble is not actually in the measurement but in the means taken to effect it. In these designs the flow into the plant is not maintained as a single flow but divided into flows and meters provided for both flows. In other words, a split flow, with all its accompanying ills.

Control of Flow

All the evidence of the last ten or twenty years shows a tendency towards more and more stringent demands for a better water and indications are not lacking, as will be shown later on, that the tendency is towards more and more complicated and complex chemical treatment.

Even with only one chemical to be applied, it is practically impossible to secure a satisfactory chemical treatment of a split flow, while with more than one chemical to be applied the difficulties become insuperable.

The very first essential to an economical, accurate and correct application of chemical treatment is a single, undivided flow. This must be maintained until all chemical treatment preceding filtration has been applied and until such last treatment shall have had time to become perfectly assimilated and distributed in the water and it should be maintained until coagulation has been completely and satisfactorily formed. To split the flow before this has been done is most certainly to create trouble and probably lower the efficiency of the plant.

With the probability of stricter and stricter standards apparently already under way, the necessity for maintaining the flow as a single flow until after all the chemical treatment has been made becomes more and more insistent and we are glad to note that few designs show any tendency to depart from the single flow proposition.

Even after filtration has been completed, the necessity for uniting all the flows from the filters into one single flow to receive additional chemical treatment is already apparent in a number of plants which are attempting such results.

Chemical Treatment

Very obviously, much will depend on the chemical treatment to be given. Some plants are designed, apparently, with no thought of ever using more than the single chemical they were designed for. Many engineers seem to think that this is all that will ever be required, but the general trend of the art is very decidedly against any such conclusion. During the last ten years our physical chemistry experts have shown us many things we never dreamed of previously and their work has already been reflected to a certain extent in the recent designs of some plants but nowhere near the extent probable in the years to come.

To continue to regard a city's filtered water supply merely as a purified raw product or a raw product purified, if you will, is definitely out of line with the apparent trend of chemical treatment. We can no longer look upon the removal of bacteria, be it ever so perfect, nor the complete elimination of turbidity and color as the ultimate in water purification; we are now well past that point and rapidly going forward to a more advanced ideal, which will answer our purpose as an ideal for a very limited period of time and then be replaced by another, just as much in advance.

In the early days it was thought sufficient to remove the turbidity and color and also the major part of the bacterial life. Then the demand for softened water came along. Following this, came the very insistent demand for sterilization. Following rather closely on this came recarbonating demands to prevent incrustation. Next we hear suggestions for treatment of the water supply, asking that iodine be added to the entire supply in order that some afflicted with goitre shall be benefited. Then, because some water without filtration, and others with it, are found to be violently corrosive, we have the demand for decarbonating the water supply.

In the meanwhile the sanitary standards were being altered from time to time, becoming stricter and stricter until water that ten years ago would have passed anywhere without question is now regarded with suspicion and tomorrow will probably be severely condemned.

Look at it in the light of these matters and it will be clear that the trend is unquestionably towards a more complex and increasingly difficult chemical treatment and with this the engineer faces more and more difficult problems in chemical control and application. All of this is past history, but it reenforces and emphasizes the necessity for single flow control.

The Use of Alum

The old form of feeding this material in the empirical strength solution has largely been supplanted by the newer and more satisfactory dry feed chemical machines which measure out a given amount of the dry granulated alum and dissolve this and carry it to the water to be treated. Most of these machines are still operated as fixed rate devices, i. e., a given amount of the dry granulated alum is fed out at regular intervals, thus providing a constant rate of supply of alum, regardless of the variation in the rate of flow of water into the plant.

With the chemical being fed at a fixed and constant rate and the flow of water varying, the result is more or less similar to what would obtain if the water were maintained at a constant rate of flow and the rate of the application of the chemical varied. Any such arrangement must necessarily mean that the water is not being treated with a uniform and unvarying amount of the chemical; in other words, each gallon of water entering the plant will receive a larger or smaller quantity of chemical treatment than other water entering at other times. This is not conducive to the best nor most economical results.

Regardless of this well known fact, proportional dry feed chemical machines

have not come to the front as rapidly or as universally as it was thought they would. Such machines would automatically increase the amount of chemical fed into the water as the flow of water increased in volume, and decrease the amount as the water flow decreased. This would assure each gallon of water entering the plant receiving exactly the same treatment as any other gallon, as long as the machine setting was not changed.

The reason for this type of dry feed device failing to become as popular as it was thought it would is probably to be found in the inability of the manufacturers to adapt the type of dry feeder they made to function as a proportional rate machine, and maintain them in successful operation as proportional rate dry feed machines.

Sulphate of Iron

The statements in relation to alum apply with equal force to sulphate of iron. One or two dry feed machines are announced which can be readily adapted to feed either granulated alum or sulphate of iron and one is now on the market. This last has proven very satisfactory in every respect, either as a fixed rate machine or as a functional rate device for the same purpose.

The trend has been away from the functional rate and towards the fixed rate dry feed for all chemicals but with only one machine available and that only quite recently, the failure of the functional rate dry feed machine to attain popularity is rather easily explained. With more machines of this general type, it is believed the trend would have been and will now be more generally in the direction of the proportional rate dry feed machine.

In this field, in the last ten years, we have two marked changes in practice, neither of which was then foreseen. Lime is a difficult material to handle, either dry or wet, hydrated or in the form of the oxide. The difficulties are varied and much time and ingenuity have been required to meet and overcome them.

At the present time there is one machine on the market which apparently overcomes all difficulties in handling lime, whether it be in the form of the oxide or hydrate. It is, however, much more advantageously employed to handle a dry granulated oxide of lime. It combines in itself a dry feed device which can be used as either a fixed rate or proportional rate machine, and when so used it will feed this material very accurately and with practically no difficulty. After feeding out the proper quantity of dry granulated lime, it then automatically hydrates the amount fed and feeds the dry hydrated product into a beater, where it is converted into a milk of lime and then introduced into the water to be treated. It is the only machine of this type as yet available which can be said to be entirely successful.

It is believed this machine affords those wishing to apply lime functionally to a changing flow of water the opportunity of so doing and that its employment for this purpose will become rather general.

Lime Has No Equal

Where lime is to be used, either at fixed or proportional rate, it is certain that nothing has yet appeared to equal it and it is doubtful if any machine to equal it in efficiency, accuracy and freedom from trouble will be developed in the near future, and be as easily adaptable to either fixed rate or proportion rate-application.

Taking it by and large, it may be said that the last ten years has seen the fixed rate dry feed machine come into its own. Apparently the dry feed machine is destined to monopolize the field in the future unless some developments now under way should oust it partially from its present position.

While it was not seen ten years ago that it might be possible to feed and hydrate an ordinary granulated oxide of lime, this is now an accomplished fact. Another thing not then foreseen was the possibility of developing a special form of oxide of lime which could be employed and fed into water as a chemical reagent without special hydrating treatment previous to its introduction into the flow carrying it to the point of treatment.

This development is only about one year old. In fact, it is so new that even the name is not clear. The new product is known as Pebble Lime. There appears to be some doubt as to just what constitutes Pebble Lime. In some sections of the country it consists of a lime broken into small and fired in a rotary kiln, much as cement is burned. Probably this is the true Pebble Lime, but this does not of itself prove that it has the characteristics suiting it to be used in water purification processes as it is supposed to be used.

It is supposed to be a very hot lime, which will slake completely even in an excess of cold water. Some of the lime sold under this name really seems to make good the claims. Others do not.

It is easily granulated and when so granulated, it can be fed from most of the dry feed devices now on the market with adequate accuracy to meet most needs of a fixed rate dry feed device. In every instance within our knowledge it feeds more satisfactorily from any of the dry feed machines on the market than dry hydrated lime can be made to feed from the same machine.

Where it is up to standard and made from lime free from magnesia, Pebble Lime may be fed directly into a small flow of cold water with apparently satisfactory results, so far as has been demonstrated. It is too early and the data too meager as yet to be sure but apparently it affords some hope that a great deal of the difficulty in feeding lime may be obviated and if this can be done much of the objection to its use will be nullified and its use will probably become more universal in water purification processes.

The Use of Soda Ash

Where sulphates are to be removed or free mineral acids neutralized, soda ash is practically our only available reagent and finds its largest use in softening plants. In the past, it has generally been employed as a solution but the dry feed machines have been found fairly successful in handling this material and are now largely supplanting the old wet feed methods, with the probability of monopolizing the field in the not distant future unless another development previously referred to should interfere.

From the preceding, it will be seen that the trend of the art is towards the use of the dry feed chemical machines. It must be remembered that a mechanical filter plant is first, last, and all the time, a chemical treatment proposition and if the chemical treatment goes wrong, the plant goes wrong, regardless of everything else that may be right. Unless the chemical treatment is accurate and certainly reliable, the plant will fail to that extent, no matter how good it may be or how well it is operated otherwise.

Saturated Solutions

The most vitally important item, therefore, is correct chemical treatment. Dry feed chemical machines have come into vogue in these plants because they offered or were supposed to offer a better and more certain chance of maintaining a more exact and reliable chemical treatment than anything else available.

A saturated solution is one which contains all of some one or more substances which it is possible to be held in solution. Some substances, such as lime, are only very sparingly soluble in water, a saturated lime water solution containing only about 60 grains to the gallon. Other substances, such as alum, sulphate of iron and soda ash, are very much more soluble and form very much stronger saturated solutions.

Another characteristic of saturated solutions is that they are of constant strength. By this we mean that a saturated solution of any of these substances will be of the same strength at the same temperature and pressure. Thus, if the temperature does not change, and if the

Description of the New Activated Sludge Sewage Plant for Los Angeles County

Installation Planned for Temporary Service Until White Point Outlet is Completed; Costs Carefully Worked Out

By A. M. RAWN

Asst. Chief Engineer, Los Angeles County Sanitation Districts

THE plan for sanitary sewage disposal from the Los Angeles County Sanitation Districts, comprising certain areas lying south and east of the City of Los Angeles, contemplates the construction of converging trunk sewers flowing generally south and southwest to a point of concentration north and east of Harbor City, at which point the sewage will be treated and flow thence, through conduit and tunnel, discharging into the ocean a mile off shore from White Point in 100 feet of water. Application for permit to discharge at White Point was placed before the California State Board of Health on April 4th, 1925.

Apprehension on the part of residents in the vicinity of the proposed outfall resulted in protests filed with the California State Board of Health requesting certain changes in the method of treatment of the sewage prior to disposal, and length of outfall and suggesting alternate locations, with the result that final action on the part of the State Board of Health with reference to the White Point outlet was delayed until April 2nd, 1927, at which time a permit for disposal of sewage at White Point was granted to the Sanitation Districts.

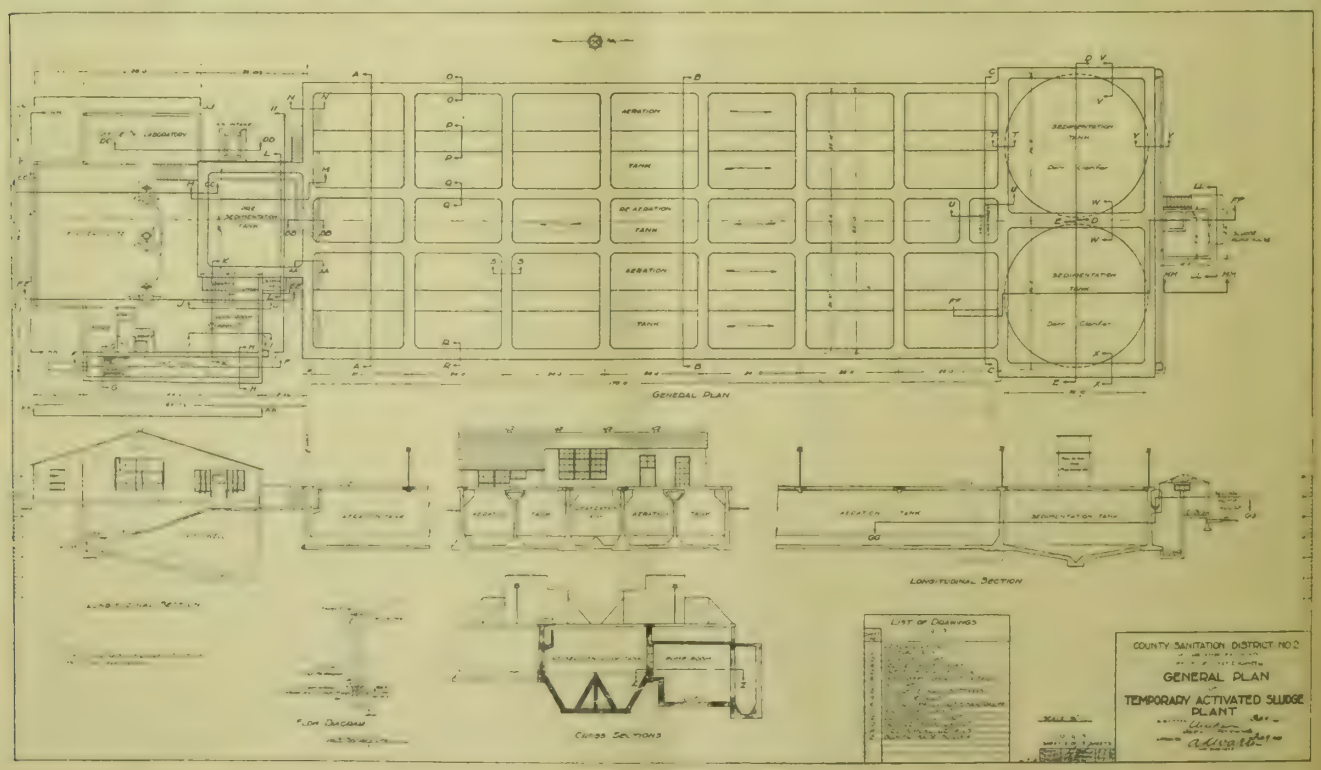
Job Will Take 2 Years

Construction progress estimates made at the date of filing the original application presumed that the necessary time essential for completion of the project would be about two years and that by the expiration of such time the need for sewage disposal from some of the areas to be served by the district trunk sewers would be exceedingly vital. Following the predictions of that early date, conditions have been growing more serious through each year of delay in the consummation of the District plan until, at the present writing, certain areas within the districts are in dire need of relief. However, as the main trunk sewer construction to the ocean could not go forward without the permit from the State Board of Health, it is now estimated that about two years more will elapse before final completion of the major project, and before relief can be secured by the plan originally proposed.

In the interval between the date of the original application and the present time more than half of the district trunk sewers have been constructed so that the system is in a position to serve the areas in greatest need, provided a temporary means of disposal of the accumulated sewage is provided. Responding to the urgent requirement, it is proposed, by the Sanitation Districts, to construct and operate an inland treatment plant until such time as the ocean disposal line, for which permit has been granted, can be completed.

Activated Sludge Type Chosen

Discharge of the effluent from such a treatment plant into the inland water channels of the County or directly into the harbor, necessitates purification ot the highest degree while the short period of operation involved until construction of the major outfall dictates the economy of plant construction with low construction costs even at the expense of high



operation charges for the comparatively short period of operation. Estimates indicate that the activated sludge type of treatment plant is the best answer to both of these requirements and such a type of plant has been decided upon.

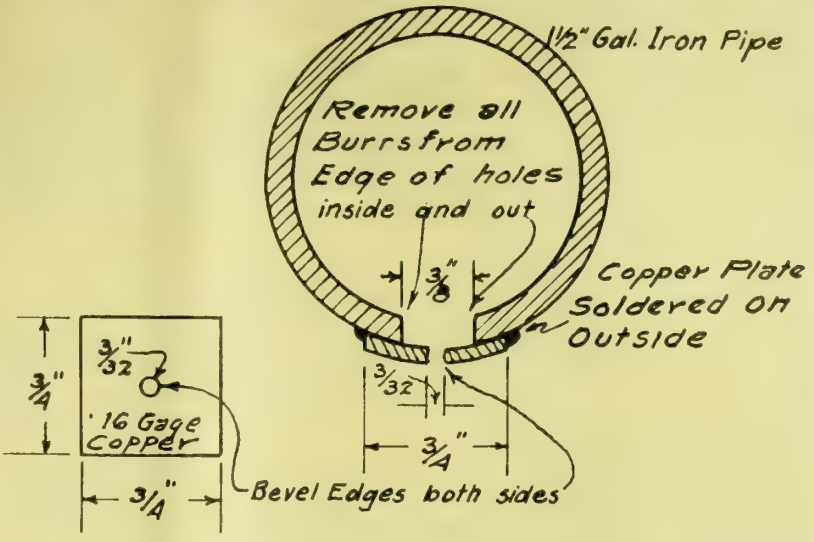
Study of the discharge from areas similar to those which are now in extreme need of sewage disposal facilities under this project indicates that a present plant capacity of 3 m.g. per day will meet the immediate requirements and that by making provision for expansion into a 6 m.g. plant it is likely that all of the areas, which can be sewered with local collecting lines prior to the completion of construction on the major outfall sewer, can be served.

The plant location which has been approved by the State Board of Health is such that the construction of the joint trunk sewer from Districts Nos. 1 and 2, as contemplated in the original plan of the districts, may be used to convey the sewage to the treatment plant site, and the design of the plant is such that all of the tanks can be readily converted into sedimentation chambers with only minor alterations of plant equipment and as such can be made to serve in the plan contemplating ocean disposal.

Expenditures Carefully Planned

Equipment and machinery to be used in the activated sludge plant is designed to serve in pumping stations or ejector plants in the Districts after serving its purpose at the treatment plant, so that the plan for local treatment contemplates a minimum expenditure for such purpose and that mainly for labor and material which it is not economical to salvage from the plant when it is converted over into a sedimentation plant.

From the general plan accompanying this discussion it will be noted that the plan of the Districts is to divert the sewage from the main trunk sewer serving Districts Nos. 1 and 2, pass it through bar screens into a pump sump; thence lift it into a pre-sedimentation tank from which it will be conveyed by gravity flume into two primary aeration tanks. From the aeration tanks it will flow by gravity into clarifier tanks and from this latter the purified effluent will be discharged directly to waste into the Nigger Slough drainage channel and the returning sludge pass by gravity into a re-aeration tank from which it will be lifted by air lifts to mix with the incoming sewage from the pre-sedimentation tank. The period of detention in the pre-sedimentation tank is estimated to be 30 minutes, that in the aeration tanks is four to five hours with 1.5 cubic feet of air supplied per gallon of sewage introduced. The period of detention in the clarification tanks is one hour. Separate digestion is provided for reduction of settleable material ejected from the pre-sedimentation tanks and for sludge from the clarifier tanks.



Air diffuser used in the activated sludge sewage disposal plant now being built for Los Angeles County. It will be noticed that the distribution pipe is standard weight iron pipe galvanized, and that slots are cut lengthwise, and the copper plates, with the 3/32-inch holes drilled therein, soldered to the pipe, on the outside. This is a rather radical departure from ordinary methods used in this class of work..

Equipment Specified

Plant equipment consists of Nash Hytor blowers, Byron-Jackson centrifugal sewage pumps, Dorr clarifier units and Dorrco sludge pressure pumps.

The only radical departure from standard activated sludge plant construction is the type of air diffusers to be used in this temporary plant, a sketch of which is shown.

Provision is made throughout for expansion as required. There is sufficient capacity in the incoming line to handle 12 m.g. per day of sewage; the pump connections from the pump sump are such as to permit the installation of larger pumps; provision is made in the blower house for the installation of additional blower units while there is ample room on the tract purchased by the Sanitation Districts as a site for the plant to construct additional tanks when necessary. The plant site is remote from dwellings of any consequences and in an area which will probably expand industrially or as an oil tank area but presumably not before the removal of the activated sludge plant as such.

Estimated Cost

Bids are received on March 1st, 1927, for the construction of the plant indicate that the cost of a plant of this type will be about $54,000 per m.g. daily capacity, which cost includes buildings of sufficient size and accommodations to house machinery for a plant not less than four times the size of the present.

The recent action of the State Board of Health in granting the permit for disposal of sewage at White Point instead of at the Breakwater or Badger Avenue as was formerly contemplated, has caused the Sanitation District authorities to consider the advisability of locating the activated sludge treatment plant at the originally proposed site of the sewage sedimentation works north and east of Harbor City, and while the change in location has not been definitely determined upon, contract for the construction of the treatment plant at the site on Nigger Slough has not been awarded and the final decision is still to be made.

Names River Commission

Governor Hunt of Arizona has signed a bill creating a permanent Colorado River negotiatory committee of eight members, charged with the duties of protecting Arizona's interests in the Colorado River and of treating with the other six states of the upper and lower basins with a view to developing the stream for power and irrigation purposes.

Water in Plenty Predicted

Water—plenty of it—appears assured to California farmers this summer. Reports of April 5 show that there is an even 13 feet of snow at the weather bureau recording station at the Summit of the Sierras. This is the heaviest snow pack for this date in 16 years and has been exceeded only three times since the keeping of records commenced 60 years ago.

Actual Experience Proves That Apparently Safe Water Should Be Chlorinated

Cost for Such Protection on a Per Capita or Per Gallon Basis is Small Part of Cost of Collection and Distribution

By LINN H. ENSLOW

*Sanitary Engineer, The Chlorine Institute, New York City**

TO NO less an authority than Sir Alexander Houston of the Metropolitan Water Board of London, may be attributed the expression—"The only way, *apart from sterilization,* of rendering water always comparatively, if not absolutely safe, is by storage."

It has always been conceded by authorities on water purification that storage for a sufficiently great period of time and at a sufficiently high temperature is an effective means of providing for self-purification of a body of water.

It is not difficult to remember the old and erroneous supposition that water passing over stones, through rapids and over waterfalls purifies itself every so many miles. The controlling factor in self-purification of streams is length of time following pollution and not the distance traveled.

London's Experience

In the case of the London water supply, it was found that chlorination made possible a considerable saving in the cost of pumping which had been necessary to deliver the raw river water to the great storage reservoirs for partial, if not complete, self-purification. It is evident, therefore, that Sir Alexander Houston is in a position to speak authoritatively on the subject of chlorination.

In addition to bringing about great financial savings Sir Alexander Houston has been able to prove to the London people that it is entirely possible to serve them a safe chlorinated water entirely lacking in that "mawkish' taste previously complained of.

Aside from protection against even the remotest possibility of water borne disease, water chlorination possesses other assets among which may be mentioned the destruction of algae, or the prevention of its growth. Chlorination, then, has the dual function of safeguarding public supplies against disease germs, and the prevention of tastes and odors resulting from living or dead biological forms of life. In this respect even a long period of storage does not of itself effect as efficient a water treatment as does chlorination in combination with storage.

In certain climates there are other things than bacteria in water which concern the public health. Amoebic dysentery constitutes a serious and often fatal intestinal disorder contracted by drinking stored waters which contain amoebic growths not introduced from a polluting source.

An Old Story

THE story of the pollution of springs in limestone formation is never a new story but it is one of the hardest to make impressive unless the owner of the spring actually sees muddy water coming from the spring after rainy periods. The spring which is connected through underground pools and caverns with a small surface stream or series of surface sink holes clears up after the rain and with its clearing the owner frequently assumes it again safe for use. The testing of samples does not corroborate such evidence, however, and intestinal bacteria are frequently found in perfectly sparkling clear limestone springs. If a small surface stream sinks into a cave or fissure and has its exit in an apparently safe spring some miles away, this spring is but little more safe than is the surface stream which entered the underground passage.

Potential Dangers

While the writer held the position of sanitary engineer with the Virginia State Department of Health he became familiar with some of the dangers which threaten apparently safe water supplies drawn from non-populated mountainous regions and those regions with sparkling limestone springs.

As an example of the unexpected which happens, the following is cited. A water supply from a sparkling cold mountain stream apparently needed no safeguarding measures such as filters or chlorination. The bacteriological analyses consistently showed it to be good. One fellow reputed to be a "bootlegger" disappeared. Foul play was suspected and a search of the neighboring hills was made. The body was found in a mortified condition at the base of a cliff and under a rock ledge near the head-waters of the stream from which the public water supply was drawn. The searchers were aided by buzzards circling above the body. Except for the buzzards, and because of the difficult traveling over the mountain side constituting the watershed, it is doubtful that the body would have been found. The truth was that "moonshiners" were operating stills on the watershed primarily because of its impenetrability. "Moonshiners" are apt to consider water only from the standpoint of its being good stuff for cooling the still worm, so after this experience the adage of "an ounce of prevention, etc.," was brought into play and chlorinators installed to protect this water supply.

Unsuspected Source of Danger

On another very rugged and heavily wooded watershed in the mountains the hiding place of the murderer was found. For some months he had been safe from the clutches of the law with a satisfactory supply of water passing the front of his thatched hut. No one ever found a sanitary privy there so far as is known, and the people of this small but healthful mountain town were never the wiser as to what they had been exposed to.

Now let us pass from the gruesome to a happier line of thought.

So many uninhabited watersheds lying relatively near communities are just the right distance away to attract picnicers, strollers and naturalists.

Picnic parties by day and petting parties by night on the watershed are not conducive to the safety of a surface water supply. Tourist parties, hunters and fishermen all constitute potential hazards to apparently safe surface water supplies.

In more than one instance there were indications of intermittent pollution at the time of inspection of the watershed. Repeated sampling of the supply failed to reveal the presence of pollution of intestinal origin. Daily analyses were commenced with the idea in mind that the infrequent sampling had missed the periods of pollution. Only a short time later it was shown that each rain brought in-

*Prepared at the request of Dana E. Kepner, Chief Engineer, Colorado State Board of Health. Read at the Rocky Mountain Section of A. W. W. A. February, 1927.

testinal pollution into the supply. Thereafter continuous chlorination was considered essential.

Animals a Factor

Aside from human pollution of surface water supplies, there always exists the likelihood of animal pollution. Sick animals and birds always seek water and frequently are found dead in streams. That buzzards carry hog cholera is a well established fact. The remainder of the story is best left untold.

The story of unexpected surface seepage downward along deep well casings and through leaking casings is an old story and needs no repetition.

Experience and confirmatory evidence have led the writer to distrust all limestone springs until incontrovertible proof has been brought forth that they are free of intestinal bacteria at all seasons of the year and under all weather conditions. It is true that the majority are safe in dry weather, but most of them are subject to some pollution in wet weather. Sometimes without warning a previously safe spring in limestone formation suddenly becomes subject to pollution as a result of the opening up of a "fault" which crosses or is parallel to the stream bed.

Insurance Through Chlorination

There are many water supplies which need purification to remove visible impurities and for the most of the time are to be considered safe supplies.

Protection afforded through fire and life insurance is not considered an essential except as a safeguard against the potential hazards of fire and death. Chlorination of apparently safe supplies of water during the major portion of time is not essential, but like death or fire, one can not be certain of the continued absence of danger and hazard. Argument against the feasibility of protection and the insurance of a safe supply through chlorination is not tenable on economic grounds. The cost for such protection on a per capita or per gallon basis is an infinitesimal part of the entire cost of collecting and distributing the water.

The writer is of the opinion that one of the most striking bits of advertising ever put out by The Wallace & Tiernan Co., makers of chlorinating equipment, is a facsimile of a life insurance policy with wording on the exterior somewhat as follows.

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(*Continued on Page 36*)

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Vallejo, Calif., Builds 22 Miles Welded Water Line and Finds It Leak-Proof

Project Said to Be One of the First Welded Jobs in the Country and is the Longest of Its Type

WHAT is said to be one of the first completely welded pipe lines in this country and the longest pipe line of its type, was recently completed for the city of Vallejo, California. This pipe line has a length of 22 miles and was built for the transmission of water from a new reservoir in the Gordon Valley to the City's Fleming Hill reservoir, just north of Vallejo.

The city of Vallejo is situated in Solano County, California, near the head of San Pablo bay, on the east shore of Mare Island Strait. It has a population of 26,000. The water supply is municipally owned and is secured from storage reservoirs in Wild Horse Valley, about 14 miles northeast of the city.

The growth of the city as well as the increasing demand of the Mare Island navy yard (supplied by the municipal system) made it necessary to increase the water supply materially. As a result, it was decided to develop the Gordon Valley project, involving the creation of a storage reservoir in Gordon Valley at a point about 26 miles northeast of the city, and the installation of a pipe line to the city to connect with the existing municipal distributing system, a total distance of approximately 22 miles.

Pipe Line Described

The pipe line is of steel-plate construction, all seams being electric-arc welded. The pipe is 22 and 24 inches in diameter, 15 miles being 24-inch and 7 miles, 22-inch pipe. Of the 24-inch pipe there are approximately 11 miles having a wall thickness of 3-16 inches and 4 miles of 1-4-inch material, whereas the 22-inch diameter pipe has a wall thickness of 3-16 inches.

The complete pipe line was built by the Western Pipe and Steel Company, using General Electric Welding machinery. The total static head on the pipe varies from 100 to 400 feet, and all of the pipe was tested at the shop to 225 pounds pressure. A number of sections were tested to 325 pounds and a few, to 720 pounds pressure but no leaks developed in the welded seam.

Automatic electric arc welding was used at the factory for making longitudinal seams for 14-foot sections of pipe. Two of these sections were joined together by means of a circular weld using semi-automatic equipment. The 28-foot sections were delivered in the field and several sections were welded together on the surface by hand welding before being lowered into the ditch.

Passes Test O. K.

The finished 22 miles of pipe was put under final test for 48 consecutive hours in the early part of March of this year. During this length of time the pipe was held under a pressure of 200 pounds per square inch at the lowest point in the line, and was found to be absolutely free from leaks. During the 48 hours of test the line was continuously patrolled and inspected at all points but no leakage was discovered.

During the time of filling the line, but one leak occurred in the straight seam in the entire length. Nineteen girth seams showed leakage or sweats out of a total of 8200 girth seams in the entire length. Of this total, 4100 were field joints, hand welded, and the remaining seams were shop welded with semi-automatic welding equipment. The field welding equipment used consisted of several gas engine driven, General Electric welding generators.

Following the final tests and inspection, the pipe was officially accepted by the city of Vallejo on April 2.

Progress in Water Purification

(*Continued from Page 27*)

solution is at atmospheric pressure, the amount of dissolved matter will be the same, whether the solution be made today, tomorrow or next week.

Developments under way seek to utilize these characteristics of saturated solutions and it would appear that this offers a relatively cheap and practical method of chemical application which may come into rather general use in water purification systems. Due to its sparingly soluble nature, no attempt is being made to adapt this to the use of lime but for the more soluble reagents mentioned, it may be found that the proposal is of merit and it may become a very useful proposition.

Mixing Process

The flow carrying the chemical charge is usually introduced into the flow of water entering the plant at some point or at different points in its passage through the mixing chamber. This mixing chamber forms an almost indispensable part of the modern mechanical filter plant, its function being to mix the chemicals quickly and thoroughly with the water flow and to so distribute the chemical as to cause it to be disseminated through every particle of the flow. In addition it is intended to so function as to cause the formation of the flow or coagulation from very small microscopic size into large and well defined particles of flocculated or coagulated

matter and to so form this coagulation that it will settle out of suspension very quickly and completely in the settling basins.

It is probable that a well designed mixing chamber also assists materially in the completion of such slow reactions as those occasioned by the use of lime or by soda ash in precipitating lime compounds.

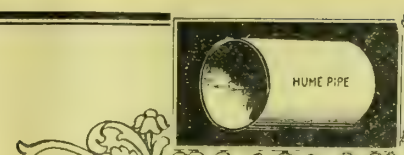
There are several different types of these mixing chambers, differing quite as radically in design as in results. Some are shallow basins so baffled that they create a flow at considerable velocity down and out along a narrow passage and in and back along a similar one, being turned at the end by a turning baffle. This type is known as the Around the End type. Another, known as the Over and Under type, has an up and down flow, passing alternately over and under deflecting baffles so arranged as to bring about this result. This type of mixer is a deeper form, the depth sometimes being 30 feet or even more, although many are not more than 20 feet deep. The deeper basins produce the better results, generally speaking.

A third type combines the two previously described and is rather efficient but also rather expensive to build. Another type is known as the hydraulic jump type; another uses mechanical agitators, while still another employs impellor wheels to force water from one to another of a considerable number of pairs of small compartments.

The time period in passing these mixing chambers varies from a few minutes to as much as one hour. All perform some work but some are more efficient than others, considering the energy consumed. Some operate under low loss of head or small power, some require more head or power. Our personal preference is for the Over and Under type, with from thirty to fifty cycles of up and down flow, absorbing about two or three feet of head and having a theoretical displacement of from 20 minutes to one hour.

Regardless of the type employed, all chemical treatment preceding filtration should be given the water before its exit from the mixing chamber and at a sufficient distance from the exit so that complete and perfect mixture may occur. While a few plants have been designed with twin mixing chambers, the practice, fortunately, is not general. Unless such design permits both mixing chambers to be used in series and independently of each other, serious operating difficulties are bound to occur and results suffer.

Twin mixing chambers, operated in parallel, necessarily involve splitting the flow, compelling a splitting of chemical treatment and all the attendant evils.



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STORAGE & DISTRIBUTION

Aberdeen Plans Its Water Supply with an Eye to Industrial Expansion

Washington Municipality Provides Gravity Flow for Big Users and Employs Pumps for Domestic Consumers

CONSIDERABLE municipal water development is now under way in different sections of the Pacific Northwest. One of the more interesting of these many projects is that of the City of Aberdeen, Washington. S. C. Watkins, superintendent of the city water department is one of the prime movers behind that city's water plan.

Aberdeen, Washington, like many enterprising communities throughout Washington, is developing its natural resources, and inviting various manufacturing industries to locate within the community. One of the most important steps in such a procedure, is to guarantee the manufacturer a reliable source of cheap water. With this thought in mind, the city council of Aberdeen instructed the water department to make a thorough investigation of the water situation, and locate an additional water supply that would provide for the contemplated uses of such industries that might be established in the city .

City's Location Described

Aberdeen is located at the extreme easterly end of Gray's Harbor, and at the mouth of the Chehalis River. The drainage basin to the north of Aberdeen is covered by the Wynooche River, which is a branch of the Chehalis, and the Wishkah River, which enters Gray's Harbor slightly below the mouth of the Chehalis, and within the city limits of Aberdeen. The Humptulips River, which is on a slightly different watershed, is directly north and west of Aberdeen. One of the main tributaries of the Humptulips is the East Fork, which extends eastward toward the watershed of the Wynooche. The headwaters of the Wishkah are located directly between the East Fork of the Humptulips, and the main trunk of the Wynooche. The present water supply of Aberdeen is now located on the headwaters of the Wishkah.

The city of Aberdeen, some time ago filed water rights upon both the Humptulips and the Wynooche Rivers. The adjoining city, Hoquiam, also filed upon the Humptulips River. For a while, it was thought that a joint pipe line could be built by both communities which would serve as a common supply, but, while the proposal met with considerable favor from some factions, it was finally decided to build the Aberdeen supply independent of Hoquiam.

In making the investigations of the available sources, Mr. Watkins considered them from the standpoint of economic development, cheapness of the supply, and the potential reserves available in case future expansion was necessary. The Wynooche River was thoroughly investigated along its entire course, from the mouth, just south of Montesan, for a distance of thirty miles up the river. Other sites were also investigated, such as the Humptulips, and the results of these investigations were laid before the city council for action.

Wynooche River Sites

The Canyon Intake is located upon the Wynooche River, approximately 30 miles north of Montesan. In order to deliver water to Aberdeen from this site, it would have been necessary to construct 27.6 miles of pipe line. This would have given a gravity flow to the city which would have arrived at a rather high head, but as only the domestic supply required such a high head, and the water was to be used primarily for industrial plants, the high head was unnecessary. Also, there were several points along the proposed route of the pipe line from this site which would have necessitated rather heavy and expensive construction.

The Bliss Ranch Intake, also located on the Wynooche River, would have been a pumping proposition. The pipe line was short, but there was no possibility of a gravity flow. The installation cost would have been low, but other sites were available which were considered better and more economical.

The Humptulips Intake, which contemplated location upon the Humptulips River about thirty miles due north of Aberdeen, was considered, but in view of the fact that a high masonry dam would be necessary, that the water shed of the Humptulips was considerably less than the Wynooche—assuring a smaller future supply—and that the plan would be considerably more expensive than even the Canyon Intake site, this location was discarded soon after the investigation started.

Whedekind Creek Site

The Whedekind Creek site is located on the creek of the same name, a short distance above the point where it enters the Wynooche River. There were two possible plans at this location. One was to pump the water from the site to a rather high elevation, and allow gravity flow from there to the city, the water entering the present mains at a pressure sufficient for distribution throughout the entire area to be served. The other plan was to bring the water by gravity from the site to within a short distance of the city, and then pump it from this point to some of the higher distributing areas where it was needed.

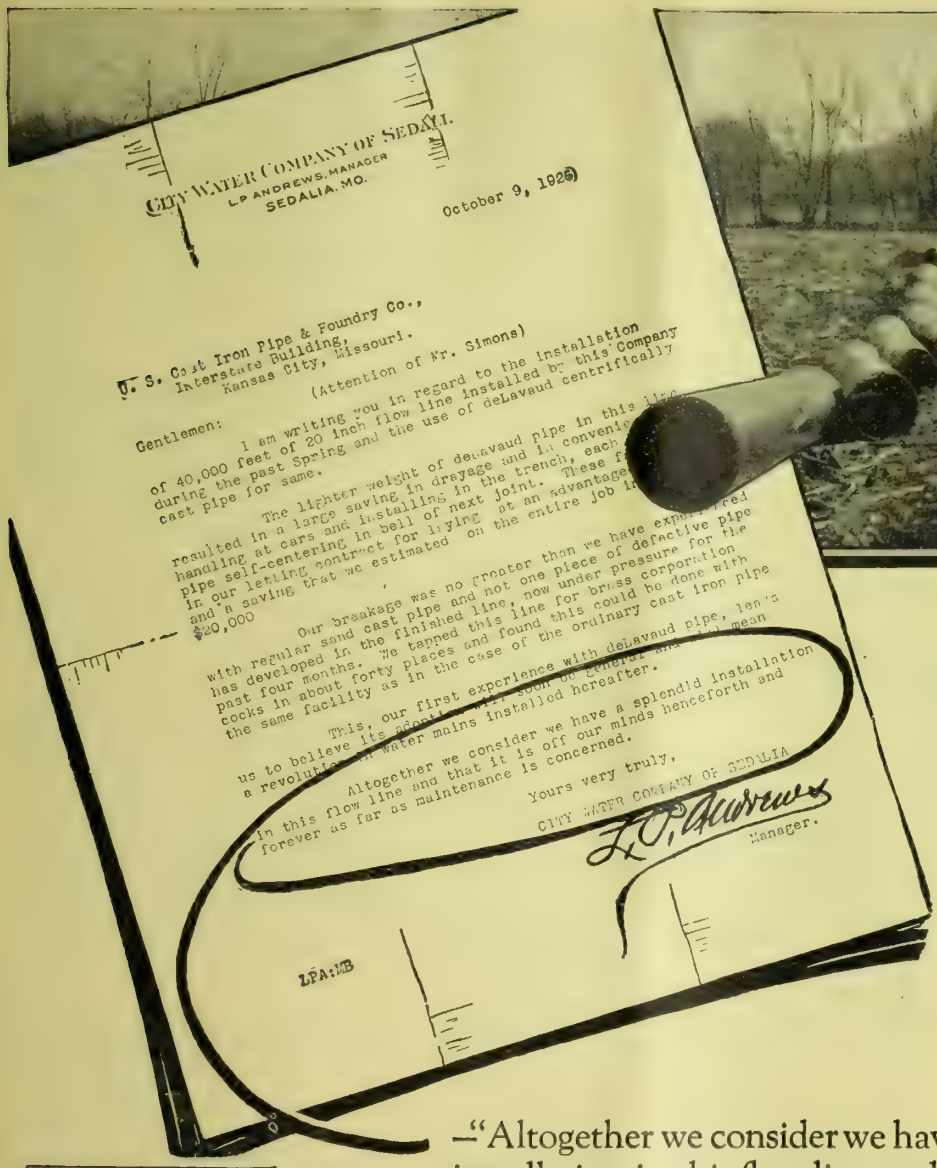
In this latter plan, the greater portion of the water could be delivered to the industrial tracts by the gravity line, and only a small portion of the water taken from the site would have to be pumped, as comparatively a small amount of it would be needed to serve the high sections of the city. The initial installation cost would be comparatively low, and the price of delivered water would be low, both of these factors making for a very economic development of the project.

The comparative costs of supplying water from all of the different sites which were under consideration is given below:

COSTS OF SUPPLYING INDUSTRIAL WATER TO ABERDEEN, PER 1,000 GALLONS

	30 Million Gals. Delivered	30 Million Gals. Distrib.	60 Million Gals. Delivered	60 Million Gals. Distrib.
Wynooche canyon gravity	.0233	.03105	.0147	.02245
East Fork Humptulips gravity	.0220	.02975	.01505	.02280
Wedekind creek gravity	.01092	.01855	.00662	.01425
Wedekind creek pumps	.0126	.01998	.00892	.01625

The plan which was finally adopted, and is now being carried out was to build the intake on Whedekind Creek, tunnel from this site for a distance of approximately three miles, and then pipe the water for another two and one-half miles to the easterly city limits. The industrial sites are located close to the terminal of this pipe line, and as the greater part of the additional supply is to be used by the industrial concerns, this could be delivered by gravity flow, without additional pumping. The pipe


CITY WATER COMPANY OF SEDALIA.
L.P. ANDREWS, MANAGER
SEDALIA, MO.
October 9, 1926
U. S. Cast Iron Pipe & Foundry Co.,
Interstate Building,
Kansas City, Missouri.
(Attention of Mr. Simons)
Gentlemen:
I am writing you in regard to the installation
of 40,000 feet of 20 inch flow line installed by this Company
during the past Spring and the use of deLavaud centrifically
cast pipe for same.
The lighter weight of deLavaud pipe in this
resulted in a large saving in drayage and in convenie
handling at cars and installing in the trench, each
pipe self-centering in bell of next joint. These f
in our letting contract for laying at an advantage
and a saving that we estimated on the entire job i
$20,000
Our breakage was no greater than we have experienced
with regular sand cast pipe and not one piece of defective pipe
has developed in the finished line, now under pressure for the
past four months. We tapped this line for brass corporation
cocks in about forty places and found this could be done with
the same facility as in the case of the ordinary cast iron pipe
This, our first experience with deLavaud pipe, leads
us to believe its
a revolution
Altogether we consider we have a splendid installation
in this flow line and that it is off our minds henceforth and
forever as far as maintenance is concerned.
Yours very truly,
CITY WATER COMPANY OF SEDALIA
L. P. Andrews
Manager.
LPA:MB

Installation of 20" deLavaud Centrifugal pipe at Sedalia.
Burns & McDonnell,
Consulting Engineers, Kansas City, Mo.

—"Altogether we consider we have a splendid installation in this flow line and that it is off our minds henceforth and forever as far as maintenance is concerned."

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line and tunnel are being built to deliver 30,000,000 gallons daily to the easterly limits of the city, and this can be increased, without a very great additional expenditure, to handle twice the amount.

The water from Whedekind Creek is not as pure as the water from some of the other sites which were considered, but it was decided that any of the water that was required for domestic consumption from this supply, would be filtered and chlorinated before being delivered into the domestic system. This will give even better water than that which is now being used, and the supply is unlimited.

Chlorinate "Safe" Water

(*Continued from Page 31*)

On the first page attention is called to the exceedingly cheap protection which water chlorination has afforded communities. A reproduction of the policy is shown here as a matter of interest and the novelty of such advertising.

Arguments Against Chlorination

It has been exceedingly unfortunate for the good reputation of chlorination that the process was not more adequately understood in the early years of its history.

Due to the difficulty of adjustment of chlorine dosage to that amount which would produce effective sterilization without leaving a residue of chlorine imparting a bad odor and taste to the treated water, chlorination as a whole received a "black eye" in the estimation of the public and waterworks men at large.

Since the advent of scientific but simplified control of the chlorine applied, the taste "bugaboo" has largely disappeared. Of course there are some instances where industrial wastes present in the water produce compounds of vile taste when chlorine is added, but just within the past year a method of overcoming this difficulty has been perfected by N. J. Howard at Toronto, Canada. It consists of "super" or excessive chlorination and after the chlorine has destroyed the nuisance producing compounds, the excess chlorine is removed by applying sulphur dioxide gas just as chlorine gas is applied. One would never know that this drastic treatment had been given the water.

Again returning to the matter of chlorine control measures applicable to ordinary chlorination: Through the application of a single test any ordinary operator may determine just how nearly perfect the chlorine application is within 10 minutes after drawing the water sample.

The LaMotte Chemical Products Co. of Baltimore, Md., has recently devised a simple compact testing outfit. The Wallace & Tiernan Co. of Newark, N. J., also has a testing oufit for sale.

The operator has two yellow colored solutions to serve as guide colors. The sample of chlorinated water is taken at a point very close to that of chlorine application. Ten to fifteen minutes after collection some of the test solution is added to the sample in the test bottle or tube. A yellow color develops immediately if sufficient chlorine is being added. If the chlorine is more than sufficient, the color will be deeper than either of the standard guide color solutions. In this event the chlorine should be throttled slightly until a test sample shows a yellow color equal to either standard, or is between them. Naturally a lighter color than that of the lightest standard solution indicates that the chlorine should be increased.

If the quality or the rate of flow of the water varies, naturally the chlorine feed must be varied to suit the changing conditions.

The explanation is simple. A considerable portion of the chlorine added to a water combines with the invisible organic matter in solution. Only that slight excess needed to kill the bacteria is indicated by the test. Therefore a change in season or the rainfall will most likely cause a change in the chlorine required for best effect.

Not being cognizant of the above relationship between chlorine and organic matter and the changing quality of the water, the early practice was to operate continuously with a single setting of the chlorinator. What resulted was periodic underdosing and low efficiency followed by overdosing resulting in chlorine taste and odor in the water. In addition to these disadvantages, corrosion of fixtures and water meters by excess chlorine added to its bad reputation.

Advantages of Chlorination

For several years the City of New York has realized that chlorination of water acts as a check on algae growth. New York and several other places have found that considerable improvement in the taste of the water can be secured by destruction of the oils of the dead algae with chlorine alone. It is peculiarly true that a small quantity of chlorine applied to algae infested waters and those containing decayed organic matter produces a bad tasting water. These tastes are classified as "bitter," "woody," and, in extreme cases, "iodoformish." The remedy in such cases is not reduction of the chlorine. To the contrary—an increase of chlorine destroys these combination products and produces a more palatable water.

In the warmer climates this trouble

(*Continued on Page 40*)

Cast Iron Replacing Steel

HERE is a steel main just two years old—wrapped and coated—being discarded in favor of McWane Precalked Joint Cast Iron Pipe of the same size.

For "The street is going to be paved and we can't risk anything but cast iron pipe under paving," says the head of this foresighted public utility.

The Precalked joints made laying this main a very swift and simple process, speeding the work, lowering the costs, and HOLDING THE WATER.

"Pacific States" McWane Pipe is also made in Open Bell B. & S. design for use with cement joints made in the trench.

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For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

WATER PURIFICATION

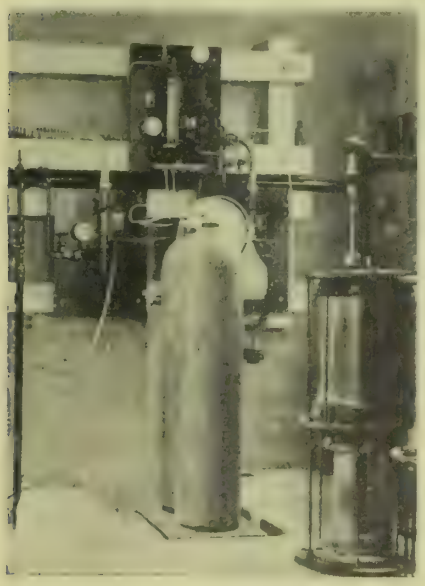
Most Modern Equipment and Practice in Los Angeles' Chlorination Plant

Dominant Thought in Hollywood Lake Installation is Uninterrupted Service; "Chloro-Scale" Used for First Time on Coast

By CARL WILSON

Bacteriologist, Los Angeles Bureau of Water and Supply

ONE of the most recent reservoirs to be built on the Los Angeles municipal system is Lake Hollywood, which was created by the construction of Mulholland Dam across the mouth of Weid Canyon on the northern outskirts of Hollywood.



This view shows the instrument board at the Lake Hollywood chlorination plant. A certain percentage of the water is taken from the main pipe line, given the proper chlorine doseage, (accurate record of this being kept by the chloroscale shown in the photo) and then returned to the main line by means of Ross pumps. These pumps operate upon the hydraulic ram principle.

The lake has a total capacity of two and one-half billion gallons and a maximum depth of 183 feet, and is supplied with aqueduct water, either directly from lower San Fernando Reservoir by conduit, or with return water from irrigation in the San Fernando valley which is retrieved through a group of wells at the Lankershim pumping plant.

The quality of the water in the past has been such that purification had not been regarded as necessary, but realizing the inevitable development of the hills surrounding the lake for residential purposes in the near future, the department planned from the beginning for a chlorination plant on the outlet to treat all the water entering service. Since there was no urgent need for this treatment, it was decided to take sufficient time in designing the plant to incorporate the most modern equipment and practice.

Automatic Control

Because of the fluctuating flow, which varies between 10 and 35 second-feet, it was necessary to use automatic machines, which greatly complicated the problem. Construction of the plant was commenced a year ago, and it was placed in operation in March, 1927. This plant is different in some particulars from any other on the Pacific Coast, although the city of Los Angeles has for some time been operating three other automatically controlled plants of high efficiency.

The dominating thought in planning the apparatus at Lake Hollywood was to so design it that operation should never be interrupted, and of course all equipment was provided in duplicate.

The concrete structure that houses the chlorination equipment has been built for permanence, and makes a very suitable building for the purpose.

Because the chlorine is introduced into a pressure main, it was necessary to use injectors, and the water pressure on the injectors has to be about five times the pressure in the main in order to satisfactorily accomplish the work under high chlorine feeds.

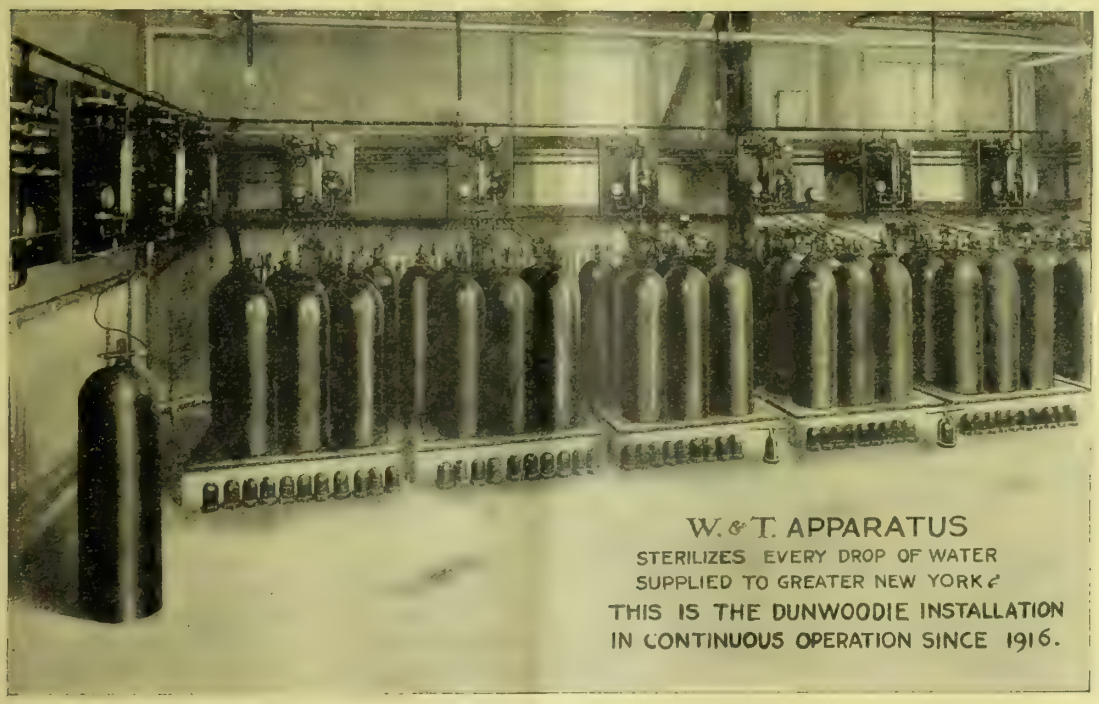
Electrically driven pumps were originally selected to deliver water for this purpose under a pressure of 250 pounds, but with a view to eliminating interruptions in their operation, due to failure of the electric current, it was decided to use Ross hydraulic pumps, which operate on the ram principle. Four of these in parallel are sufficient to provide all the water necessary, but six pumps were installed in such manner that any four of them may be used, thus enabling easy repairs to any units which may get out of order. Two of these pumps can actually carry the load for a short time, so that even should one or two of them get out of service during the night, or while the operator is absent, there would be no interruption to chlorination.

Guardians of Los Angeles' Domestic Water Supply. Left to right, S. M. Dunn, assistant chief engineer; Dr. Carl Wilson, bacteriologist; Jess Chandler, construction foreman, and C. C. Williams, operator of the Hollywood Lake chlorination plant.

Two Chlorine Machines

Two Wallace and Tiernan chlorine machines, each having a capacity of 100 pounds of chlorine per 24 hours were installed, and either machine is sufficient to handle any flow of water which is likely to be encountered. Instead of holding one machine idle as a stand-by, the two machines are operated continuously with half the load on each. This practice is followed in all of the Los Angeles chlorine plants, so that in case of accident to one of the machines, instead of chlorination stopping completely, the remaining machines would intro-

Chlorination Must Be Dependable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THE Dunwoodie installation is a case in point. Placed in operation April 4th, 1916, the original units are still in service.

Although in this period over one hundred thousand million gallons of water have been chlorinated at this plant there has not been a *single* instance of interrupted sterilization!

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duce at least 50 per cent of the required dosage.

Another innovation, so far as the Pacific Coast is concerned, is the employment of the new "Chloro-Scale" recently introduced by the Wallace and Tiernan Company. This is a platform scale provided with a recording device of the Bristol type, which makes a graphic record on a 24-hour chart of the amount of chlorine fed. By comparing the "Chloro-Scale" chart with the chart from the Simplex Recorder, it is possible to see at a glance whether the chlorine machines have actually operated automatically in perfect accord with the fluctuating flow of water. Such a record would become of utmost importance in proving the efficacy of chlorine treatment, should an outbreak of infectious disease ever be imputed to the water supply.

Design of Chlorine House

The chlorine house itself, as will be seen from the photograph, is a substantial reinforced concrete structure which was especially designed for the purpose. It is well-ventilated and well-lighted, while ample room has been given for working upon any piece of apparatus without interfering with the operation of the others. Electric heat with thermostatic control has been provided to maintain the room temperature at a constant minimum of 50 degrees Fahrenheit, in order to prevent "freezing" of the tanks during cool weather.

A tap for taking samples has been located on the main 300 feet below the point of chlorine application, and samples taken here at frequent intervals are tested for free chlorine with ortho-tolidin for the purpose of controlling dosage. The testing equipment is kept in the chlorine house and readings are made by the plant operator every time he inspects the machines, which is several times each day. The free chlorine readings are recorded on the operating record, and each entry is attested to by the signature of the operator.

Chlorinate "Safe" Water

(*Continued from Page 36*)

is encountered frequently. In Texas the writer was privileged to visit two plants where the operators of their own accord had discovered through experimentation that the proper remedy was excess chlorine and not reduced dosage. Naturally this practice gives best results where the heavily chlorinated water may be passed through long pipe lines, service reservoirs, or is subsequently aerated before passing into the distribution system.

Through a bit of very recent research conducted by the Texas State Department of Health it has been shown exactly what dosages of chlorine are necessary to kill and thereafter prevent aftergrowth of certain algae. In some instances the use of copper sulphate (bluestone) for algae control is not feasible. The questionable practice of applying this chemical to small reservoirs, tanks or basins where a sufficient period for the reactions is not available has led many to favor chlorine as an algaecide. Chlorine in such cases has the advantage of serving as a bactericide and algaecide simultaneously.

Chlorine Effects Savings

In certain cases where the collecting tanks, coagulating basins or service reservoirs are subject to heavy algae growth it has been necessary to control this trouble by complete emptying of the unit and the thorough cleaning of the walls and bottom. Chlorine applied ahead of such units appears to effectively prevent algae growth and thus saves considerable expense of cleaning, waste of water, and prevents out-of-service periods for cleaning operations. The saving at the Texas plants was considerable. In colder climates this item may not be of the same importance.

In cases where waters are aerated to oxidize iron and remove odors due to sulphur gases the chlorination of the aerated water will destroy the residual hydrogen sulphide, the odors, and also oxidize the remaining iron. Algae growth is also retarded if not entirely eliminated.

Greater Efficiency

The reduced consumption of coagulants which has been brought about at certain filter plants as a result of prechlorination is an item of importance. This effect seems to be a result of artificial aging of the colloidal coloring matter and simultaneous algae destruction. Consequently the filters run for considerably longer periods between washings.

Chlorinated water does not produce the mass of green slime-like growths on cooling tower coils and around condenser tubes frequently obtained with unchlorinated waters. The efficiency of heat transfer in condensers and cooling towers is therefore increased.

There are many less important roles played by chlorine but the paper begins to wander and since the topic "Why Chlorinate Apparently Safe Water Supplies?" has been covered in a fashion, the purpose for which the paper was intended has been fulfilled.

The author wishes to add that Mr. Dana E. Kepner, of The Colorado State Department of Health, has offered valuable suggestions toward the perfection and manipulation of an improved chlorine testing outfit.

Middle Rio Grande Project

(*Continued from Page 13*)

produce and an accessible outside market.

This project is not a development of a new 'raw land" area, however. It is materially different from such a development in that it has a large population already on the lands and thus demands no colonization. It has substantial assets, land, homes, cities and utilities, forty million dollars in assessed valuation. The project is already a "going concern"—the most important and thickly populated community of the fourth largest State in the Union.

Conservation and Restoration

The Rio Grande Project at El Paso, with an irrigable area of 155,000 acres, has gross annual crop values of about $12,000,000. Land and climatic conditions here are very similar to those pertaining on the former project which is located on the same river about 200 miles south of the center of the Middle Valley.

The proposed project's work is truly a problem of conservation and restoration. The work is vital to the present life of the valley, for without relief, the present agriculture can not long be sustained. It is vital to future development since improvement in existing conditions can not be made by the individual or even by small groups of individuals, but depends upon the concerted action of the entire valley.

The Owyhee-Vale Projects

(*Continued from Page 19*)

fork of the Malheur river, which holds 170,000 acre-feet. The dam is to be heightened ten feet to impound 50,000 acre-feet more. This dam was built in 1919 by the Warm springs irrigation district.

Cost of Projects

The cost of the Owyhee project is estimated at $17,715,000, and for this year the appropriation is $2,000,000, which with $315,000 heretofore appropriated and on hand, makes a total of $2,315,000 available at this time.

The cost of the Vale project is about $3,587,300. There was appropriated this year $850,000, which with $500,000 heretofore appropriated, makes a total of $1,350,000 available for this project.

Appropriations available for the two projects total $3,665,000. It is expected that the first unit of the Vale project will be completed by March 1 of next year. Other units will be completed yearly until the projects are fully completed, which probably will be in 1931 or 1932.

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California Water Companies Make Annual Report

Growth in 1926 Shown by Increase Over 1925 in Both Operating Revenue and Expenses

Through the California Railroad Commission financial statements of various water companies in the state are being made available. These reports give a summary of figures for 1926 as compared with those of 1925. The four companies whose reports are given below, the East Bay Water Company, the Spring Valley Water Company, Monterey County Water Works, and San Jose Water Works, all show an increase in business in 1926 over that of 1925.

Spring Valley Water Co.

Spring Valley Water Company, operating in San Francisco, reports to the California Railroad Commission its 1926 operating revenue at $6,066,847.51, as compared with $5,664,337.34 for 1925. The operating expenses, excluding taxes for 1926, are reported at $2,863,338.70, and at $1,800,372.92 for 1925, leaving net operating revenue of $1,898,337.00 for 1926, and $3,863,964.42 for 1925. During 1926 taxes charged to operation amounted to $965,001.70, and for 1925 to $907,646.14. Deducting the taxes leaves operating income of $4,168,510.51 for 1926, and $2,956,318.28 for 1925. Adding to the operating income, the non-operating income of the company and deducting non-collectible revenue and rents, results in a gross corporate income, (which represents the amount available for interest, amortization of debt discount, other fixed charges, non-operating expenses, dividends and surplus), of $3,405,153.43 for 1926, and $3,427,437.78 for 1925.

East Bay Water Company

East Bay Water Company, operating in Oakland and vicinity, reports its 1926 operating revenue at $4,194,245.57, as compared with $3,694,375.61 for 1925. The operating expenses, excluding taxes for 1926, are reported $1,666,830.65, and at $1,458,441.69 for 1925, leaving net operating revenue of $2,527,414.92 for 1926, and $2,235,833.92 for 1925. During 1926 taxes charged to operation amounted to $506,906.19, and for 1925 to $443,233.80. Deducting the taxes leaves operating income of $2,020,508.73 for 1926, and $1,792,700.12 for 1925. Adding to the operating income, the non-operating income of the company and deducting non-collectible revenue and rents, results in a gross corporate income, (which represents the amount available for interest, amortization of debt discount, other fixed charges, non-operating expenses, dividends and surplus), of $2,111,067.53 for 1926, and $1,899,581.82 for 1925.

Monterey County Water Works

The Monterey County Water Works, operating in Carmel, Pacific Grove and Monterey, reports its 1926 operating revenue at $177,830.29, as compared with $155,864.13 for 1925. The operating expenses, excluding taxes for 1926, are reported at $88,899.97, and at $82,973.81 for 1925, leaving net operating revenue of $88,930.32 for 1926, and $72,890.32 for 1925. During 1926 taxes charged to operation amounted to $18,114.53, and for 1925 to $17,364.88. Deducting the taxes leaves operating income of $70,815.79 for 1926, and $55,525.44 for 1925. Adding to the operating income, the non-operating in-

come of the company and deducting non-collectible revenue and rents, results in a gross corporate income, (which represents the amount available for interest, amortization of debt discount, other fixed charges, non-operating expenses, dividends and surplus), of $84,140.16 for 1926, and $63,631.91 for 1925.

San Jose Water Works

San Jose Water Works, operating in San Jose and vicinity, reports its 1926 operating revenue at $602,847.43, as compared with $562,979.44 for 1925. The operating expenses, excluding taxes for 1926, are reported at $249,181.08, and at $243,858.99 for 1925, leaving net operating revenue of $353,666.35 for 1926, and $319,120.45 for 1925. During 1926 taxes charged to operation amounted to $73,953.79, and for 1925 to $56,056.34. Deducting the taxes leaves operating income of $279,712.56 for 1926, and $263,064.11 for 1925. Adding to the operating income, the non-operating income of the company and deducting non-collectible revenue and rents, results in a gross corporate income, (which represents the amount available for interest, amortization of debt discount, other fixed charges, non-operating expenses, dividends and surplus), of $279,006.16 for 1926, and $263,625.46 for 1925.

Twenty Million Dollar Water Company is Incorporated

Subsidiary of Federal Water Service Corporation Will Purchase Holdings for $9,422,475

Articles of incorporation for the California Water Service Corporation, a $20,000,000 concern subsidiary to the Federal Water Service Corporation, were accepted in Sacramento recently by Secretary of State Frank C. Jordan.

The corporation is combining in one concern a number of formerly independent water companies throughout California.

The directors listed in the incorporation papers are James D. Adams, Harold A. Black, Benjamin B. Logan and John T. Piggett, of San Francisco; D. D. Crystal of Berkeley, and Robert T. Patton and Ray Vandevoort of Oakland. The papers were filed by the law firm of McCutcheon, Olney, Mannon & Greene of San Francisco.

The Railroad Commission authorized the new corporation to purchase, at a price not to exceed $9,422,475, certain water company holdings throughout the State. It also was given permission to sell $2,000,000 of common capital stock.

The properties whose purchase was authorized include the water plants of the Pacific Gas & Electric Company in Dixon, Stockton, Livermore, Willows, Oroville and Redding, and also the properties of the Fresno City Water Corporation, the Electric Water Company of Bakersfield, the Bakersfield Waterworks, the Hermosa-Redondo Water Company, the Port Costa Water Company, the Chico Water Supply Company, the Chico-Vecino Water Company and the W. E. White Company of Chico.

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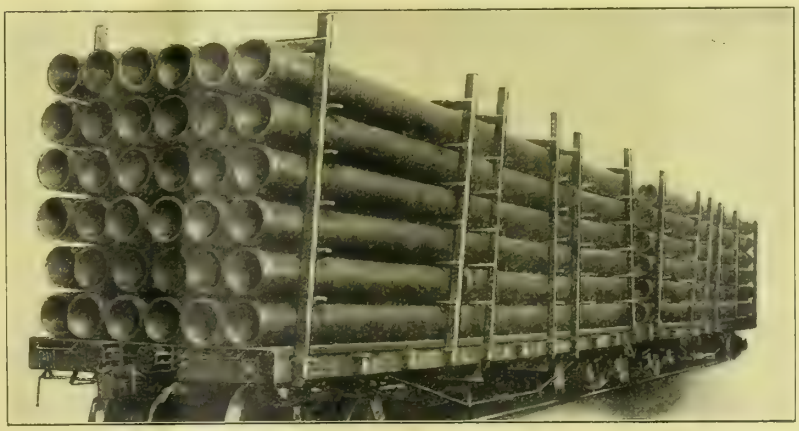

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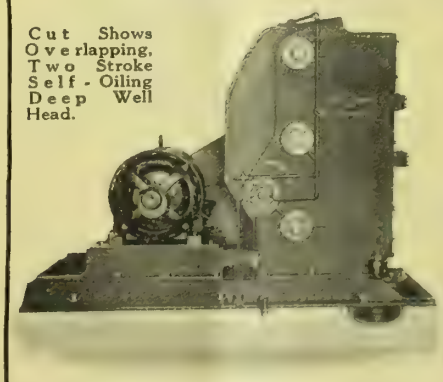

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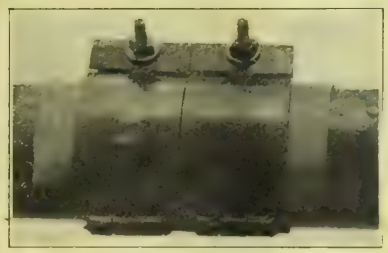

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With the California Railroad Commission

Must Supply Water for Mining

El Dorado Water Company, operating in the vicinity of Placerville, El Dorado County, has been directed by the California Railroad Commission to furnish water for mining purposes to Thomas H. Gerle, Grant G. Gerle and Henry Reynolds. The water company filed its complaint with the Railroad Commission alleging that the two Gerles and Reynolds had applied to it for water for mining purposes, but that under its contract for its supply of water from Western States Gas and Electric Company, the water company is under obligation to resist all applications for water for mining purposes. The Railroad Commission held that complainant has rates for furnishing water for mining purposes on file with the Railroad Commission, and should be required to furnish the water applied for, in the absence of a definite showing before the Commission that there is no water available to meet the application for water for mining purposes. . The Commission dismissed the complaint so far as it relates to Western States Gas and Electric Company.

O.K. Water Service Co. Purchases

California Water Service Company was today authorized by the California Railroad Commission to purchase from C. B. Jackson the Chico-Vecino Water Company and the W. E. White Water Company of Chico, a lot in the city of Visalia, used in connection with the operation of Visalia Water Company; the water plants of Pacific Gas and Electric Company, held under contract by C. B. Jackson, and located in Dixon, Stockton, Livermore, Willows, Oroville and Redding; and also the properties of Fresno City Water Corporation, Electric Water Company of Bakersfield, Bakersfield Water Works, Visalia City Water Company, Hermosa-Redondo Water Company, Port Costa Water Company and Chico Water Supply Company, at a total purchase price of not to exceed $9,422,475.

The Commission also authorized California Water Service Company to issue and sell $2,000,000 of common capital stock, reserving to future orders the authorization of any additional stocks and bonds covering the purchase price of the acquired properties.

Terms of Water Transfer Fixed

In supplemental orders issued the California Railroad Commission has authorized Pacific Gas and Electric Company and C. B. Jackson, representing California Water Service Company, to enter into an agreement covering water purchased by Pacific Gas and Electric Company from Jackson or California Water Service Company, from water plants transferred by Pacific Gas and Electric Company to Jackson, or California Water Service Company, subject to a condition imposed by the Commission requiring a definite statement of the quantities of water to be furnished Pacific Gas and Electric Company.

The Commission has also amended its previous order authorizing Pacific Gas and Electric Company to transfer its water plants at Stockton, Oroville, Redding, Willows, Livermore and Dixon to California Water Service Company direct instead of to C. B. Jackson, agent of that company.

Fresno Wants Sale Price Set

The City of Fresno has filed an application with the California Railroad Commission to fix the just compensation to be paid by that city to the California Water Service Company for the water system in the City of Fresno formerly owned by Fresno City Water Corporation. This system was recently acquired by the California Water Service Company under authority of the Railroad Commission under an order authorizing that company to acquire Chico-Vecino Water Company, W. E. White Water Company, of Chico, Chico Water Supply Company, Visalia Water Company, Electric Water Company of Bakersfield, Bakersfield Water Works, Hermosa-Redondo Water Company, Port Costa Water Company, Fresno City Water Corporation and water plants of Pacific Gas and Electric Company located in Dixon, Stockton, Livermore, Willows, Oroville and Redding, at a total purchase price of not to exceed $9,422,475.

Must File Plans for Additional Water

After an investigation of the complaint of W. J. Parker and seven other water users against C. Gulling operating a water system in the town of North Portola, Plumas County, in which it was alleged that the water service is inadequate, the California Railroad Commission has directed Gulling to file reasonable rules and regulations for the conduct of his business with the Railroad Commission, and to refrain from taking on additional consumers until he has provided an adequate supply for all existing consumers. Defendant was also ordered by the Commission to file with the Commission plans for obtaining an additional and adequate supply of water for all consumers on or before July 15, 1927.

Apply for 20-Year Lease Permit

Ed Fletcher, operating Sherman Water Company, and James K. Diebold, and the city of Beverly Hills, have filed a joint application with the California Railroad Commission for permission for Fletcher to sell the properties of Sherman Water Company to Diebold, and for Diebold to lease to the City of Beverly Hills, with option to purchase the same, the "Sherman Water Properties." The proposed lease is for a period of twenty years, and the City of Beverly Hills is to pay $833.33 every month for the first 10 years, and $1,000 per month during the last 10 years of said lease.

Ask Rehearing on Rate Increase

Mattie L. Goodwin and Grace Webb, copartners, operating Quincy Water Works at Quincy, Plumas County, California, have filed a petition for a rehearing of their application for an increase of rates, by the Railroad Commission. Petitioners recite that the rates established by the Railroad Commission in its recent order will produce a net return of about six per cent only, and that the utility is entitled to a return of eight per cent upon a rate base of $58,030, instead of a rate base of $26,630, allowed by the Railroad Commission.

Files Complaint Against Water Co.

Cazadero Community Club, by its Trustees, Frank J. Schneider, Mike Bohan, John Speetzen, has filed a complaint with the California Railroad Commission against George S. and Carrie Judd Montgomery, operating a public utility water system in the vicinity of Cazadero, alleging inadequate service and asking the Railroad Commission to order

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improvements in the service, and that defendants be required to develop an adequate water supply for the needs of their consumers.

Ask Permit for Note Issue

Natomas Water Company, operating a public utility water system for domestic, irrigation and mining uses in El Dorado and Sacramento counties, has applied to the California Railroad Commission for authority to issue a promissory note for the sum of $92,000, payable on or before four years from date with interest at six per cent for the purpose of refunding an outstanding note.

Will Issue Note for $92,000

Natomas Water Company has been granted authority by the California Railroad Commission to issue its promissory note in the sum of $92,000, payable on or before four years from date with interest not to exceed 6 per cent per annum, for the purpose of refunding an outstanding note of like amount.

Grant Transfer of Pumping Plant

East Gardena Water Company has been authorized by the California Railroad Commission to transfer a strip of land including a well and pumping plant to the Board of Public Service Commissioners (water and power commissioners) of the City of Los Angeles for the sum of $10,750.

District Will Take Over Water Co.

El Dorado Water Corporation has applied to the California Railroad Commission for authority to sell its water rights and property to El Dorado Irrigation District, and the latter has applied to the Commission for permission to acquire and operate the said property in the county of El Dorado.

Water Co. Plans Improvements

Portola Water Company, operating in the vicinity of the town of Portola, Plumas County, has applied to the California Railroad Commission for permission to issue $10,760 of capital stock, and not to exceed $5,000 of promissory notes for the purpose of financing additions and betterments.

Ask Permit to Sell System

Fred A. Braley and E. T. Gruwell, operating Oak Park Water Company on Tracts Nos. 7747 and 901 Los Angeles County, have applied to the California Railroad Commission for authority to sell that utility system to Guy B. Humphrey for the sum of $10,000.

Will Buy Baldwin Park Water Co.

Baldwin Park Domestic Water Company has applied to the California Railroad Commission for the necessary authority to sell its property to Baldwin Park County Water District.

Transfer of Bolinas Co. Authorized

The California Railroad Commission has authorized Bolinas Water and Power Company to transfer its ublic utility water system to Bolinas Public Utility District, Marin County, for a consideration of $2,009.

San Dieguito Co. Will Stop Service

The California Railroad Commission has authorized San Dieguito Water Company to lease and sell its properties to the City of San Diego, and to abandon water service.

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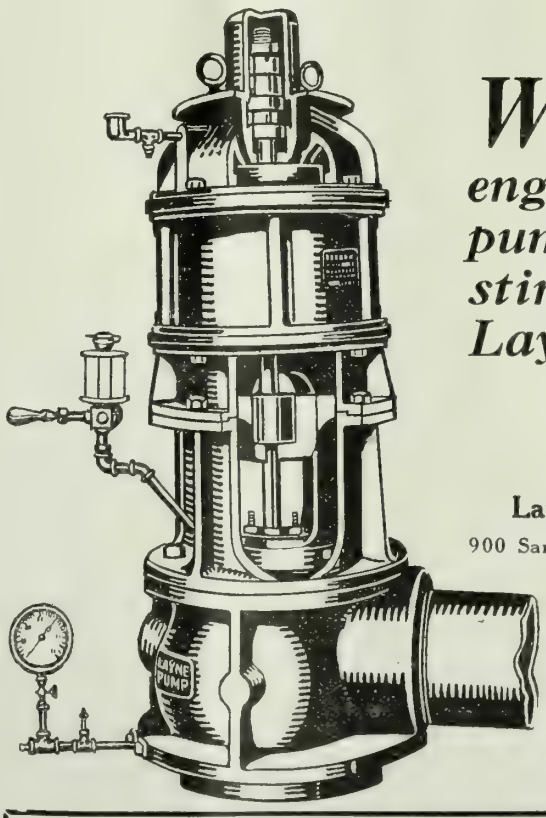

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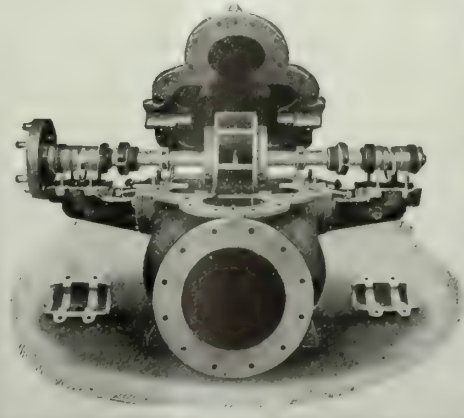

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LEGAL *and* JUDICIAL

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The Term "Reclamation" Declared to Include "Irrigation."

The right of a reclamation district to provide irrigation upheld.

In the case of Hershey et al. vs. Reclamation District No. 108, Volume 73, Cal. Dec. page 310 the Supreme Court considers a comparatively recent amendment to the reclamation laws whereby such districts were given the right to irrigate lands.

In holding that the term "reclamation" also includes "irrigation" the Court states:

"Reclamation includes irrigation in its general, ordinary sense and is sufficiently broad and comprehensive to include the irrigation of lands which are rendered excessively dry and arid in the summer seasons by reason of the shutting out of the storm and flood waters of winter."

On the question of the right of a reclamation district to provide for irrigation the court says:

"There is authority holding that an irrigation district possesses independent powers necessary to drain its overflowed lands and to protect its land owners from seepage and overflow waters as well as to supply water to the dry and arid lands of the district. (Authorities cited.) The conclusion reached in the above cited cases must rest upon the theory that the two methods employed to reclaim lands are germane to a general purpose and in accord with the policy of the government."

Ditch Owners Are Not Insurers Against Damage

Negligence must be shown in an action for damages from seepage.

In the case of Munn vs. Twin Falls Canal Co. 252 Pac. Rep. 865 (Idaho; Oct. 29, 1926) the rule of law as to seepage damage in that state is set forth by the Supreme Court as follows:

"That one who conducts irrigation water through a ditch, or uses it on his land is not liable for injury caused by seepage, unless he is negligent in the construction or operation of his ditch, or the use of the water."

In reference to the use of water the Court states:

"It is a cardinal principle established by law and the adjudication of this court that the highest and greatest duty of water be required. The law allows the appropriator only the amount actually necessary for the useful or beneficial purpose to which he applies it. What constitutes a reasonable use of water is a question of fact, and depends upon the circumstances of each case. No person is entitled to use more water than good husbandry requires. It is the duty of the canal company—as much as of a user under such canal, not to knowingly permit the waste of water. It is as much against public policy for a canal company to knowingly furnish water in excess of the needs and beneficial use of a consumer, with knowledge that such consumer is wasting it, as it is for the consumer to waste it, and a company which knowingly furnishes water to a consumer in excess of any beneficial use, or with knowledge that it is not being put to any beneficial use and is being wasted by being permitted to seep needlessly upon the lands of another, will be liable for such damage as the seepage may cause, upon proof of such violation of the policy of the law, which of itself would establish negligence, and that such negligence directly contributed to the injury."

Jail Sentence for Disobedience of Court Order

A stipulated form of court order and judgment is binding on the parties.

In order to settle a controversy over water used for fish hatcheries a decree and order was made by the trial court, with the consent and approval of the parties, which provided for the use of water by one claimant for hatchery purposes and subsequent use of the same water by the other claimant, the first user not to decrease the amount of water.

Later the defendant was cited for contempt for disobeying this order, he having wasted the water, changed his method of use and otherwise made the Court order ineffective, and was committed to jail.

In upholding the order of the lower court the Supreme Court of Colorado in the case of Heil vs. Hubbel 252 Pac. 343 (Jan. 10, 1927), states:

Improvement Districts Provided for by Oklahoma Law

Constitutionality of the act is attacked on several points.

On an attack made against the organization of a water improvement district in Oklahoma the plaintiff contended that a special organization could not be created to purchase or construct water mains and distributing systems, that the act was insufficient by reason of not providing the length of time of publication of notice of assessment, and the meetings of directors were illegal by reason of being held outside of the district.

On these various points the Supreme Court of Oklahoma in the case of Lowerty vs. Water Improvement District No. 5, 251 Pac. 748 (Dec. 21, 1926) holds:

"The provisions of the Constitution of Oklahoma grants these powers to cities and towns, and such provisions are not intended as a limitation on the powers of the Legislature. . . .

"The Legislature has a wide discretion in determining the kind of notice to be given, though not having the power to dispense with all notice. . . . The notice in the instant case, in our opinion, was reasonable, and the act is not unconstitutional by reason of its failure to specify the number of publications required of such notice. . . .

"It might be that in some cases the board of directors should hold their meeting within the confines of the district, yet, under the conditions just set forth, such proceedings in our opinion, would not be irregular or void, because said meetings were held in the county seat and without the confines of the district."

"There are more reasons than one why we must accept the June, 1924, consent decree as determining the rights of the parties. It was a final order, entered some two years and three months before the case was brought here for review; it defined the parties' rights and is res judicata; they both acquiesced in it, then and thereafter, the last time in their common agreement for the appointment of commissioners to see that the decree should be carried out. It is too late now for defendant to assail it, directly or indirectly . . . The point is that, . . . the order was violated, and the thought cannot be entertained that defendant can defeat plaintiff's rights by violating the decree, or that courts are so impotent that they cannot order the restoration of a condition: i.e. the former line of the stream flow, interrupted by defendants' active violation of the court's former order. If it be attended with inconvenience to defendant, it was of his own making."

Surplus Water Subject to Use in Oregon

The ownership of a water right is not affected by lack of ownership in a ditch.

In the case of in re Rogue River Adjudication 251 Pac. Rep. 898 (Jan. 4, 1927) the Supreme Court of Oregon lays down the rule for the use of surplus water as follows:

"It has always been the policy of the law, and still is, to permit any person to make any beneficial use of any surplus water flowing in any non-navigable, public stream, and if there is any surplus water during the high-water season, Cameron, like all other persons, may apply the surplus to any beneficial use, but not during any ordi-

any beneficial use, but not during any ordinary stage of the water, and not at a time when the water is being used by parties below for irrigation purposes, nor in any way which would deprive any person of the quantity of water adjudicated to them by said decree."

The point was raised, that one of the parties had no title to the ditch and therefore could not maintain his claim for a water right. To this the Court replies:

". . . these proceedings were to determine the ownership of water rights, and not of the ditches through which those rights are used. . . . Where an appropriation for the irrigation of land was made by means of a ditch by one having only a revocable license in the ditch, the rights of the appropriator to use the water thus appropriated for the irrigation of the land would not be terminated or defeated by the revocation of the license."

Herminghause Case Goes to United States Supreme Court

Defendants file petition for writ of certiorari.

The defendants in the noted case on riparian rights, Amelia Herminghaus et al. vs. Southern California Edison Company, 73 Cal. Dec. 1 (Dec. 24, 1926) have appealed to the Supreme Court of the United States, a petition for a writ of certiorari having been filed February 19, 1927. The principal grounds on which it is claimed that the Federal courts have jurisdiction are:

(a) In the broadest aspects, the case involves the rights of the United States and its licensees or agencies to store waters of streams flowing through the lands of the United States for the development of hydroelectric power, the defendant being in possession of the lands required for reservoirs by licenses issued by the Federal Power Commission.

(b) The San Joaquin River being a navigable stream the storage of water is in aid of navigation and such matters are within the jurisdiction of the Federal Courts.

(c) Before the Supreme Court of the State the plaintiffs challenged the validity of the "Water Commission Act" on the ground that it took property without due process of law in violation of the Fourteenth Amendment of the United States Constitution, which contention was upheld by the Supreme Court of the State, and for that reason the United States Supreme Court has jurisdiction over the question.

Tri-County Flood Control

Plans for the organization of a huge flood control and water conservation district taking in San Bernardino, Riverside and Orange Counties have been started. Expenditure of millions of dollars for flood control dams and the putting into effect of conservation measures in the territory served by the Santa Ana river watershed were seen as necessary by the officials who attended the preliminary meeting. It is declared that it will take the conservation of all the run-off for a number of good years to restore the water plane to its 1922 level.

Oregon State Legislature Makes Changes in Irrigation Laws

The thirty-fourth legislative assembly of Oregon passed a number of bills making changes in the irrigation laws of the State, all of which came from the committee on irrigation and drainage, of which Senator George E. Davis was chairman. Among these measures are the following:

One bill provides for determination of the earning values of the land and permits the districts to compromise with their creditors and to refund bonds and meet obligations as agreed upon, to establish a basis similar to that allowed under the federal law, which is known as the Fact Finders bill. This bill is an enabling act, giving districts power to settle with their creditors, if settlement can be effected.

Other legislation changes the certificate of the secretary of state which shall be indorsed upon bonds in that it requires this statement, "this bond is not an obligation of the State of Oregon."

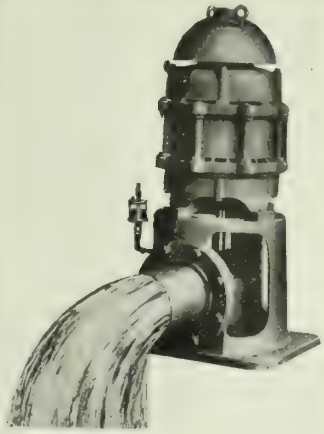
Another bill abolishes the desert land board and places its duties under a reclamation commission, so that all these duties are now to be performed by one body. The new commission consists of the governor, secretary of state and treasurer, with the state engineer, secretary to the reclamation body. The commission has supervisory powers.

One measure gives to each individual land owner a right to pay out his own charges and to be relieved from pyramiding assessments, subject however, to default and non-payment of the district of its obligations with a charge for a sinking fund which is limited to not more than 50 cents an acre.

Still another new law makes it easier for districts to dissolve, permitting district improvement companies to be included within irrigation districts, a measure of advantage to pumping districts under the Owyhee project.

Will Vote on Water System

Redmond, Washington, will hold a special election on April 26 to decide whether or not to enlarge and improve the city water system. The measure to be voted upon contains the following provisions: The enlargement of an addition to the present waterworks system; the construction of a dam across Seidel Creek and of a settling basin on adjacent land and the acquisition of rights of way therefore. The estimated cost is stated to be $27,000, and to pay this the measure provides for the issuance of $7,000 of general indebtedness bonds and not to exceed $20,000 of 6 per cent water revenue bonds, said water revenue bonds being a lien solely upon the revenue of the water system of the town.



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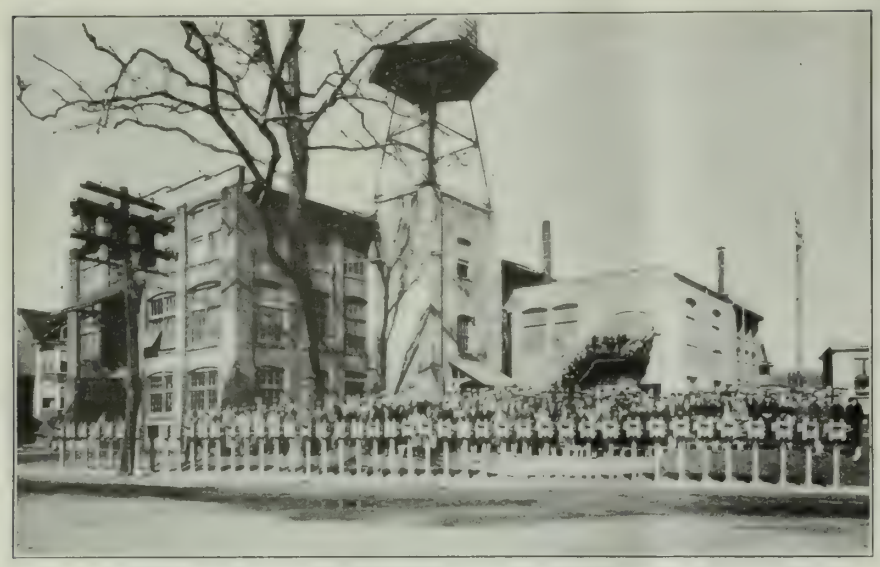


CHLORINATORS FOR TWENTY-TWO CITIES

Showing the Wallace & Tiernan plant at Newark, N. J., with a portion of the W. & T. organization and, in the fore ground, the 44 Chlorinators ready for shipment to Chile

Largest Shipment of Chlorine Control Apparatus to Chile

Inspeccion De Agua Potable Y Desagues Orders Forty-four W. and T. Units for Sterilizing Water Supplies

The chlorination of drinking water is sometimes regarded as a typical American practice, but it is interesting to note the rapidity with which chlorination is spreading throughout the world.

Wallace & Tiernan Co., Inc., the largest manufacturers of chlorine control apparatus, within the last few months have made several large export shipments to Japan, India, Brazil, Argentine, Uruguay, Chile and other countries. The largest of these shipments is shown in the accompanying illustration—forty-four of their new Type MSP and MDP chlorinators for the Inspeccion de Agua Potables y Desagues of Chile.

The contract, it is said, was placed with Wallace & Tiernan Co., Inc., after very thorough investigation and indicates not only the prestige of this particular organization in the foreign field, but the leadership of the United States in the manufacture of equipment of this type.

In order better to care for their rapidly expanding foreign business, Wallace & Tiernan Co., Inc., in addition to having authorized agents throughout the world, maintain their own offices in Buenos Aires, London and Paris.

Take Over Scale Business

Fairbanks, Morse & Co. of Chicago, has taken over the scale business of The Fairbanks Co. of New York, it was officially announced at the company's office on April 1.

In 1916 Fairbanks-Morse purchased E. & T. Fairbanks and Company, with its scale factories at St. Johnsbury, Vt., and East Moline, Ill. The Fairbanks Co. of New York, however, held the distributing rights for Fairbanks scales in the Eastern and Southern portions of the United States and abroad. The present transaction, therefore, gives Fairbanks-Morse complete control of the manufacturing and distribution of Fairbanks scales.

Built for Rough Going

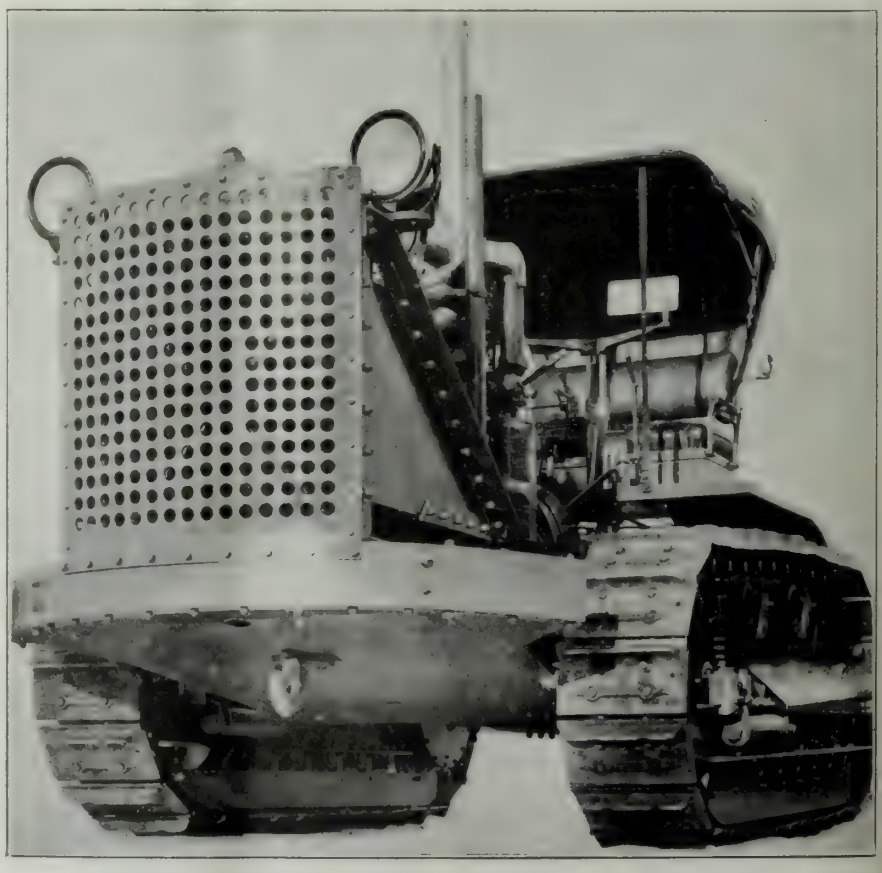
The Caterpillar Tractor Co. of San Leandro, California, and Peoria, Illinois, has just brought out a new armored bumper and shield for the "Caterpillar" Sixty Cruiser.

The bumper practically extends across the entire front of the tractor, connecting with a heavy armored steel guard sheet under the forward working parts of the machine, and with a perforated steel radiator shield.

The bumper and shields are designed for tractors operating on construction jobs conducted in brush and dense undergrowth. The steel underguard sheet is of such strength as to bear the weight and stall the tractor should it ride up onto a stump.

In practical operation, the armored bumper and shields give maximum protection to working parts of the tractor, longer life, and a wider field of operation in handling logs.

The bumper and shields are designed to protect the working parts of the tractor from underbrush, limbs and stumps, only. They are not constructed for use as a battering ram to butt down six-inch trees; a form of sport said to be popular with some enthusiastic young tractor drivers.



A View of the "Caterpillar" Sixty Cruiser with Armored Bumper and Shields.

Hovey Heads Fairbanks-Morse

At an annual meeting of the directors of Fairbanks, Morse & Company, W. S. Hovey was elected president, the former president, C. H. Morse, becoming chairman of the Board. This is the first time this position has been held by a man not of the original Morse family.

In 1919, Mr. Hovey was elected vice president in charge of all the manufacturing

activities of Fairbanks-Morse and in 1924, was made general manager of the entire business.

San Gabriel Flood Control Report Issued by Board

(*Continued from Page 17*)

of this dam in controlling such a flood or even one considerably smaller, is negligible.

The assumed floods used in these tests are not necessarily the maximum that may be expected, and are much smaller in comparison than those indicated as probable by the Chief Engineer of the Flood Control District in defending the large flood control storage advocated by him on the San Gabriel River.

The big Santa Anita dam cost over $1,000,000. It is of doubtful value for conservation, and is of no value for flood control, except for smoothing out peaks of small floods.

Big Dalton Plans Not Properly Considered

The Big Dalton Dam, with a drainage area of 5 square miles, should be in shape to handle a flood with a maximum daily runoff of at least 4,000 acre feet. This dam provides 1300 acre feet of storage and the combined discharge capacity of outlets and spillway is 1300 second feet. A runoff of 4,000 acre feet in 24 hours would more than fill the reservoir, even if it were entirely empty and the outlets wide open at the beginning of the period. Were the reservoir full at the beginning of this 24 hour runoff, the spillway and outlet capacity would be greatly overtaxed.

Here is a dam providing only 1300 acre feet of storage and estimated to cost $600,000 or more. The average yearly runoff from the small drainage area, and the periods of many consecutive years when it would have practically no water to store, make it of doubtful economic value for conservation storage. For flood control, it is of no value, except for its slight effect on minor floods. Without a larger spillway than is now contemplated, this dam is considered to be positively unsafe.

Sawpit and Eaton Canyon Too Expensive

The Sawpit dam now being constructed, and the one proposed in Eaton Canyon, both have outlet and spillway capacities sufficient to handle a maximum flood from their drainage areas without danger to the structures. Both of them are very expensive per acre foot of reservoir capacity. They are of little value for conservation storage, as it is seldom that there would be water available to store behind them. If operated exclusively for flood control, they may be of slight value, but not enough, in our judgment, to justify their high cost.

The proposed dam on Thompson Creek will have a drainage area of 3

(*Continued on Page 56*)

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OVERHEAD IRRIGATION

OVERHEAD IRRIGATION IN THE CITRUS INDUSTRY

IRRIGATION in the citrus industry is receiving considerably more attention from growers at the present time than it has at any time in the past. Arizona is devoting as much time and attention to this important subject as California. Many growers have solved a part of their problem by overhead irrigation, and there is no doubt that this relatively new method will become universal within a few years, as its many advantages become better known.

The growers in the Riverside (California) citrus area have been making an intensive study of irrigation and a report on the soil moisture survey, conducted during the 1926-27 irrigation season by the Citrus Committee of the Chamber of Commerce of Riverside County, the Agriculture Extension Service of the University of California, and E. S. Babcock and Sons, chemists, was recently submitted to the members of the Chamber of Commerce of Riverside. Among the general conclusions outlined in this report were the following:

Six Conclusions

1. The amount of water delivered by the various water companies is apparently adequate for the needs of the mature, healthy citrus trees.
2. It is probable that a thirty-day interval between irrigations is about as good a general average as could be agreed upon.
3. Improved soil management will utilize better delivery period of irrigation water.
4. Careful study of penetration of water is advised as distribution in some orchards is poor; moisture control can be improved by changed cultural practices.
5. Greater flexibility and delivery of water upon demand by water companies will benefit the community.
6. Systematic study of moisture conditions in root zone and changing irrigation practice as needed is necessary.

The conclusions of this soil moisture survey were taken from a co-operative study of over thirty typical citrus groves in the Riverside area. H. A. Lynn and D. S. Bell, heads of the Riverside Chamber of Commerce committee, were the leaders in this work.

Overhead irrigation has a great many excellent features, but it is not a cure-all for many of the grower's troubles. Opinions of various authorities upon the benefits that can be attributed to the sprinkler system seem to differ widely. This can be readily seen from the letter recently received from F. H. Macpherson, one of the pioneers of overhead irrigation, who writes:

"In a recent issue of your magazine, there appeared an article under the heading: 'What Overhead Irrigation Does.' Then followed an enumeration of the advantages of overhead irrigation as found in a bulletin issued by a company manufacturing sprinkler heads. Amongst the advantages listed were the following:

" 'On cold nights it is a proven frost protection as it raises the temperature and washes the frost from the foliage.

" 'Overhead irrigation will eventually eliminate the use of the filthy smudge pot and the labor and expense of operating these pests which ruin the fruit and smoke up everything for miles around.'

Not a Frost Preventive

"Since the writer is perhaps to some extent responsible for the general adoption of overhead irrigation in citrus groves, through experiments with, and installation of 'overhead' on his own ranch, he feels a responsibility to the citrus growers generally, when he sees such statements as the above made, fearing that orchardists who install systems with the idea of using them as and for frost preventives and frost protection, will be grievously disappointed. The writer has probably carried on experiments along this particular line, considerably further than any other person, certainly further than any one of whom he has knowledge. In an address delivered by him before the Citrus Institute, at San Bernardino, in February, 1926, he referred to these experiments in the language following:

" 'Perhaps some of you will remember upon the occasion of my first talk upon this subject of overhead irrigation before the Lemon Men's Club in Los Angeles, two or three years ago, I suggested the possibility of frost protection, to at least some extent. In the winter of 1923-4 we applied water over the whole grove by the overhead system, as a frost preventive, and were able to save both fruit and trees from frost, with the temperature at 25° over several hours. We did, however, have considerable loss from breaking down of trees and branches by the additional weight of ice. During the winter of 1924-5, the temperature went down to 23° on three different occasions and, though we applied water again (but not in as great quantity for fear of breaking down the inter-sets put in the previous summer, and, likewise, branches on the older trees) we were not able to save the crop entirely, losing about 8 per cent by frost, and having, likewise, some frost damage to the trees, both old and young. This winter, 1925-6, I have protected my grove from frost by the installation of the latest type of "smokeless" heaters, and on the one and only night we were obliged to use them, they performed very excellently.'

"From the above, it will be observed that water applied by 'overhead' cannot be depended upon as a frost preventive, where the temperature goes lower than 25° or 26°, and then there is liable to be loss from breaking down of trees by weight of ice. If the writer's advice upon this subject is worth considering, it can be stated in a few words: Don't take any such foolish chance.

"The writer is stronger than ever for 'overhead,' for the prime purpose for which it was originally installed, that of uniform irrigation, and also for the many other advantages which have developed as a result of its use, which advantages have been heretofore enumerated. He has received many compliments the past few weeks, upon the quality, sweetness, color, size and quantity, of the navel crop on his ranch."

F. H. Macpherson.

San Gabriel, Calif.
Feb. 15, 1927.

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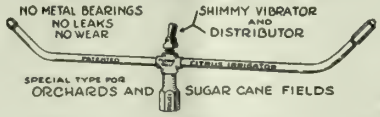

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SURVEY *of* HYDRAULIC DEVELOPMENT

A summary outline of developments contemplated on Western projects which have been announced during the month

Filtration and Chlorination

TORONTO, CAN.—The construction of an additional filtration unit before the end of 1927 was recommended by the engineer of the Canadian utilities commission, according to Assistant Trade Commissioner J. Bartlett Richards, Toronto. It is estimated that a new filtration plant unit would cost about $750,000. The present filter plant has a nominal capacity of 21,000,000 gallons daily, but its safe working capacity is reached when the average daily output is 15,000,000 gallons. It is estimated that the average daily use of water in 1927 will be about 13,870,000 gallons, or 92.47 per cent of the safe capacity. Since the construction of the additional unit will take about a year and a half, it is recommended that the work be started before the end of 1927. Further details may be obtained from the Department of Commerce, under reference Canada No. 104.

BEVERLY HILLS, CAL.—City will soon call for bids for a 5-M G. D. rapid sand filter in accordance with specifications prepared by Salisbury, Bradshaw & Taylor. Petroleum Securities Bldg., Los Angeles. An experimental plant is now open to observation of manufacturers.

SNOHOMISH, WASH.—Authorized their water superintendent to construct a small filtration plant and pumping station near the site of the old well on Pilchuck River. Work was to be started during the latter part of March, and the cost to be paid out of the water department funds.

GLENDALE, CAL.—A new chlorination plant will be installed to take care of the waters from the upper stream of Chevy Chase Creek. This work will be under the direction of Peter Diederich, water superintendent.

KIRKLAND, WASH.—The city will install a Booster pump on the main line south of the city. The cost is contemplated to be about $1500.00. The council is also making plans for the city to install a filtration plant and chlorination system for the whole water supply system.

AUBURN, WASH.—According to reports, the city water system is troubled with algae, and plans are being made to devise some method of eliminating this nuisance.

Irrigation Development

ELLENSBURG, WASH.—The contract for the construction of the Kittitas Canal has just been awarded by Assistant Secretary Finney of the Department of Interior. The contract for schedule No. 1, a distance of five miles, was awarded to the General Construction Company of Spokane, Wash., for $354,805.90, and schedule No. 2, a distance of five miles from Point Peoh west, was awarded to S. H. Newell & Co. of Portland, Oregon, for $217,949. Bids for schedules 3 to 9 inclusive were rejected and will be readvertised, as will the Tucker Creek syphon near Easton Creek. The two contracts awarded include excavation, gunite lining, and all small structures. The gunite lining will all be three-inch.

SALT LAKE, UTAH—The Sanpete Water Company contemplates the immediate expenditure of over $800,000 in improvements. This will include the construction of a 45-mile main canal in the Sanpete valley, together with a storage reservoir and tunnel at the headwaters of the canal. The financing of this project is rapidly nearing completion, and no contract awards will be made until such financing is completed.

BUCKEYE, ARIZ.—G. A. Puntney, Santa Ana, Henry Naen, San Bernardino, A. F. Zaiser, and Clarence Crookshank of Santa Ana, are inspecting land in the Centennial Valley with a view to developing several thousand acres of citrus land at a cost of $200,000. The property is located about 25 miles west of Buckeye.

MONTE VISTA, CAL.—Property owners of this district met recently with W. H. Johnstone, former superintendent of the Consolidated Water Co. of Pomona to discuss the formation of a water district for Monte Vista and surrounding territory, approximately 3000 acres. C. E. Weatherby, J. C. Pierson, V. C. Weeks, O. F. Hartley, are interested property owners.

REDLANDS, CAL.—Bear Valley Mutual Company will proceed to line all of their canals with waterproof cement in order to eliminate as far as possible the enormous water losses due to seepage. This work will be done as soon as possible in order to have the canals ready for the coming irrigation season.

SANTA FE, N. M.—The state legislature has just appropriated an additional $50,000 for the purpose of irrigation surveys within the present undeveloped areas of the state. The largest of these appropriations is for $13,000 which is to be used in drilling test wells in the Tularosa basin.

PLACERVILLE, CAL.—El Dorado Irrigation District is planning the immediate construction of a dam and reservoir at Sly Park, 20 miles southwest of Placerville, and facilities for the storage of Cosumnes River water. The district comprises approximately 30,000 acres.

RAMONA, CAL.—The irrigation bonds of the Ramona Irrigation district are 95 per cent sold. This issue is for $90,000 and the money will be used for construction work to be performed during the coming summer.

BISBEE, ARIZ.—Proposed power and irrigation project for Sulphur Springs Valley will be discussed at a meeting of valley representatives to be held shortly.

SALT LAKE, UTAH—A recent court decision will make available 8600 acres of desert land for irrigation. In the Escalante valley, near Milford, a group of California capitalists contemplate immediate development of the 8600-acre tract, constructing an irrigation system, drilling water wells, and placing the area to alfalfa. The purchasers are A. E. McGarry and H. P. Taylor of Los Angeles.

Pumping Equipment

BAKERSFIELD, CAL.—Plans are being made to increase the pumping head of station No. 7. This will require the addition of a 50 H.P. motor as well as an automatic compensator. Estimates have also been made for 8 recording flow meters to be installed at different points throughout the city.

BEVERLY HILLS, CAL.—Layne & Bowler Corp., 900 Santa Fe Ave., has been awarded contract by city at $1283 for furnishing of two deep-well turbine pumps for water department.

COLTON, CAL.—So. Cal. Edison Co. will start work shortly on a riveted steel water tower on the west bank of Warm Creek, near Santa Ana River, in East Colton. Tank will be 10 ft. in height, 10 ft.. in diam., on an elevated tower 50 ft. high. Roof will be of 10 gauge sheet iron.

CHINO, CAL.—Bids will be called at once by the executive committee of the North Towne Avenue Water Co. for drilling the new well. A flow of 75 miners inches is desired.

FILLMORE, CAL.—City trustees have authorized the issuance of the $10,000 bond issue voted recently for water supply and distribution system. C. Arrasmith, city clerk.

BAKERSFIELD, CAL.—Plans are being made for a new turbine installation at station No. 4, East Bakersfield. This will include a flow meter, and several recording gauges of different types.

PORT ANGELES, WASH.—A new water system is being planned for Rosemary, a suburb of this city. The supply will come from Barnes Creek.

SEATTLE, WASH.—Water District No. 2 has just completed a plan to supply the entire part of Kings County north of Seattle from Cedar River. This new construction will be financed by a bond issue which will be voted upon in the near future.

Reclamation and Drainage

CALEXICO, CAL.—H. H. Clark, manager of the Colorado River Land Co., has announced that work will start at once to provide an additional 10 miles of levee to protect the Imperial Valley against the Colorado's annual flood next May. Five dredgers and 800 head of stock will be required. Work will involve moving more than 1,000,000 yards of earth.

RIVERSIDE, CAL.—The Board of Supervisors of Riverside County, California, are considering plans for the realignment and control of the channel of San Timoteo Creek. San Timoteo Creek is the outlet for a considerable drainage area, including

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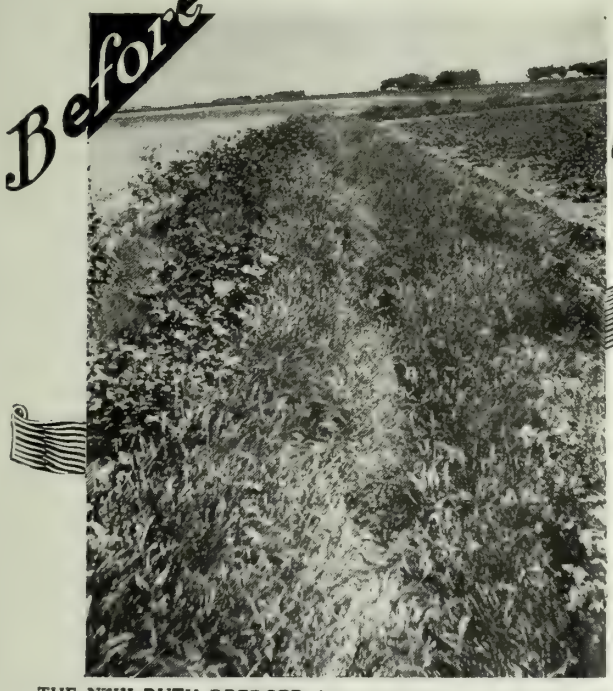

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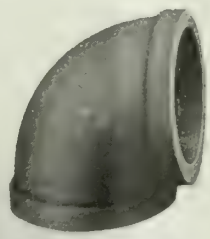

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For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

Advantages of Metering Irrigation Water

1.—It provides an equitable and just basis for all water users on which to pay their portion of the cost of operating their canal system.

The farmer who uses less water by the meter system pays less in proportion than the farmer who uses more.

2.—It provides a means of knowing how much water is applied to a field or crop. The U. S. Department of Agriculture and State Experiment stations have many times shown that the quantity of water applied to a crop sensitively influences the yield. The Universal tendency and danger is to irrigate too heavily.

3.—It encourages the farmer to save water by better field and ditch preparation.

4.—It allows him to use as much as he likes and gives it to him when and as often as he wants it.

5.—It increases the water supply by eliminating wasteful tendencies.

6.—It creates better harmony among water users and co-operation between them and the canal operators by providing a fair and just means of measurement which is beyond dispute.

7.—It will often prevent the development of seepage lands due to the removal of extravagant irrigation practices among users on new projects. This saving is often many times the cost of a meter system.

8.—The general effect of metering irrigation water is to reduce the cost of canal operation, increase irrigation efficiency, stop complaints, create better crops, and avoid expensive drainage works.

9.—The metering of irrigation water pays big dividends to the irrigators from the day it starts and always keeps on paying.

10.—The principle is sound and is being widely adopted.

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the Yucaipa district, a portion of the Oak Glen district, and much of the Beaumont area, including the range of hills immediately south of the canyon itself.

The cost of this work has been estimated at $190,000, which is divided as follows:

Right of way, $32,000; excavation of channel, $50,000; cost of bridges (four), $40,000; city reservoir repairs, $3,000; Gage canal siphon, $5,000; intake construction, $5,000; outlet, or spillway, $5,000; moving and replacing houses, $25,000; channel control work, $25,000; total, $190,000.

ANAHEIM, CAL.—Contemplating the formation of a flood control district within the corporate limits of the city, in order to afford better protection to the inhabitants. This movement is yet in a formative stage, and no definite action has been taken.

Reservoirs and Dams

EL CENTRO—According to Chief Engineer Dowd of the Imperial Irrigation Dist., dams in the proposed power system will be located at the Rositas dam site, on the Alamo River, just north of Holtville, where a 45-ft. head is available, developing 1870 h. p., the Alamo dam site, on the Alamo River, north of the first site, 13½ ft. head, 880 h. p. and the Number Eight Heading site, on the New River, north of Seeley, 12-ft. head, 400 h. p. Cost, estimated at $1,600,000.

PHOENIX, ARIZ.—Proposed work of the Salt River Valley Water Users' Association to provide complete electrification for the valley includes construction of a $2,200,000 dam about 10 miles below the Mormon Flat dam. It will have a height of 726 ft., a length of 100 ft., and provide a storage capacity of 75,000 acre ft. The power plant at this point will develop 12,000 h. p. Transmission lines will cost $100,000, and a distributing system $900,000.

MONTEREY PARK, CAL.—O. A. Gierlich, consulting engineer, 207 First Nat. Bank Bldg., Monrovia, is preparing estimates for a reinforced concrete reservoir to be built by the city of Monterey Park on the hills back of town. Estimates will be prepared on two types, viz.: 2,000,000-gal. and 2,500,000-gal.

TUCSON, ARIZ.—Will M. Neal of San Francisco, is inspecting sites for the Canyon del Oro dam for the purpose of developing mining, power and water for irrigation. Surveys have been under way under the supervision of Robert Morgan.

SANTA BARBARA, CAL.—Construction upon the new Juncal Dam is being held up by many legal difficulties. The authorities hope to have this situation cleared up in the near future, however, so that this new project can be rushed to completion.

Waterworks and Supply

TOMBSTONE, ARIZ.—C. F. Petersdorff, consulting engineer of Tucson and formerly city engineer and superintendent of the water works at Tucson, has been employed as engineer on the construction of Benson's new municipal water and fire protection system, representing R. D. Whitaker, who designed the system and has contracted to take care of all engineering on the project. The main well is down 380 ft., and will be sunk to 900 ft., where an artesian flow is expected to be encountered. Slacking clay has been found in the well, which has delayed progress in drilling, and a six-inch casing is being placed through the clay strata.

PROVINCE OF ONTARIO, CANADA—Plans for construction in the Province of Ontario, recently reported by Trade Commissioner Walter J. Donnelly, Montreal, Quebec, include the following: a $14,000,000 waterworks system and a $1,000,000 reservoir: a filtration plant of 3,000,000 gallons daily capacity. Details relative to these and other construction projects in Canada are available to accredited American firms and can be obtained by writing the Department of Commerce, reference Canada No. 105.

LICTON SPRINGS (SEATTLE) WASH.—A new 24-inch steel water main will be laid through the center of the Licton Springs territory, in order to better serve the residents of the district. The district's engineer, Willis T. Batcheller, is in charge of the work, and plans are now being made to purchase the pipe and other necessary supplies. This line will run from Maple Leaf reservoir where there is always an available surplus.

ANACORTES, WASH.—The city is about to vote upon a $50,000 bond issue, the passage of which will enable the water department to make additional pipe line installations, and improvements to the present water system. This will inclue a line to Whistle Lake, which will give additional water supply so that the city can provide the needs of some of the manufacturing plants of the city.

MARYSVILLE, CAL.—A general revamping of the water supply system, and fire department supply system, is contemplated. The citizens of this city have recently held a meeting to determine the best plan of procedure, and will again meet in the near future.

LONG BEACH, CAL.—A bond issue is proposed to extend the city water mains to serve the industrial district. There is also considerable talk about re-vamping the old steam stand-by unit in order to safeguard the city supply in case of floods or earthquakes.

PASADENA, CAL.—Resolution of intention No. 5812 adopted by city for 6-in. cast iron water main in Zanja St., from the projection south of the east line of lot 14, blk. A, San Pasqual Tract. W. C. Earle, city engineer. Bessie Chamberlain, city clerk.

BALDWIN PARK, CAL.—$225,000 water bond issue carried at recent election. Of this sum, $167,000 will be used for purchase of existing system, balance for extensions and improvements.

PORT TOWNSEND, WASH.—Plans for a complete renovation of the city water supply system will soon be completed. This work will be under the direction of W. J. Sadler, former city water superintendent.

SAN BERNARDINO, CAL.—Water department will start soon on construction of a new 4-in. main on Leonard Ave. to replace the old 2-in. line which runs 1500 ft. between Mount Vernon Ave. and Penn St.

SHAFTER, CAL.—April 26 has been set as date for election in the Shafter Public Utilities District to vote on the proposition of a local water system.

TACOMA, WASH.—The city has appropriated $15,000 for preliminary engineering work on the new Puyallup River-Lake Kapowsin water system.

ESCONDIDO, CAL.—The Escondido Mutual Water Company has decided to rebuild a 2000-foot pipe line in the valley. This new line will be four and five-inch welded.

SAN DIEGO, CAL.—The city has filed application for diversion of water from the Colorado River near Blythe.

EVERETT, WASH.—The tunnel at Sultan Headworks is nearing completion. Pipe line construction will soon be under way.

For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

BRAZIL, SOUTH AMERICA—Improvements are being planned in the water supply system of a Brazilian city and are actually under way in certain sections, according to advice received from Vice Consul Allan Dawson, Bahia. The municipal water office is interested in receiving catalogues and price lists from manufacturers of all types of materials used in water supply systems. It is particularly desirous of information upon pipe of 18, 12, 10, 6, 4, and 3½-inch diameters. Catalogues on hydrants, valves and meters of all sorts would also be welcomed. The local authorities are also interested in a chlorination system, but are unable to give specifications. Further information regarding this work can be obtained from the Department of Commerce under reference Brazil No. 237,413.

ABERDEEN, WASH.—The Wedekind Creek Junction site, on the Wynooche, has been chosen as the location for their new water plant. A special bond election will be held to provide funds for the necessary work. The system will be of the gravity type, a tunnel approximately three miles long carrying the water through the mountain and thence three miles through closed conduit. The question of a filtration plant in connection with this installation has not been decided as yet, but it is being seriously considered.

BUCKLEY, WASH.—H. W. Mitchell of Seattle, Wash., was awarded the contract for the construction and materials for the new city water supply pipe line. Mitchell was the lowest bidder, the amount being $40,000, the nearest competitor being R. M. Stock of Aberdeen, Wash., for $51,985. The city is now contemplating the purchase of fire fighting equipment, which will include several trucks, and a complete fire alarm system. The vote upon this will be made at the next meeting of the council.

CENTRALIA, WASH.—Plans have been made to replace all old wooden water mains with cast iron. The sizes will vary from 14-inch down to 6-inch. At the present time nearly sixty per cent of the city system is composed of old four-inch pipe, which is entirely inadequate for the needs of the city, and all of this will be removed and replaced with larger cast iron pipe.

LOS ANGELES—Resolution of intention adopted by county for sewers in Second St., between Meyler St., and Hanford Ave., and portions of various alleys, and Bandini St., between First and Third Sts., involving 8-in. cem. pipe, brick manholes, frames and covers, brick drop manholes, brick junction chambers, 6-in. cem. house sewers, C. I. No. 312. Hearing April 25.

VENTURA, CAL.—Water Superintendent Ed. Orton stated in a talk before the Volunteer fire department banquet that the city was desperately in need of larger supply pipes for the water system. The council has not yet voted funds for the purchase of additional pipe to adequately protect the city supply.

SAN BERNARDINO—Resolution of intention No. 2642 adopted by city for 8-in. vitrified sewer complete in Alexander Ave., between 0 ft. west of Arrowhead Ave. and 29½ ft. east of D St., including manholes, flushtanks, 9 4-in. connecting sewers, etc.; 1911 act. Protests, April 18.

LOS ANGELES, CAL.—Santa Monica Land & Water Company have announced extensive developments to be made at Huntington Palisades. This work is estimated to cost $1,100,000 and will include water mains, sewers, gas lines, etc.

CHEHALIS, WASH.—The city commission has just called for bids from the supply companies to furnish 7800 feet of 8-inch water pipe, 1200 feet of 6-inch, and 1200 feet of 4-inch, all to be cast iron.

ELMA, WASH.—A new concrete water intake will be constructed for the city water supply system. This intake will be located at Crystal Springs, three miles east of the city.

GLENDALE, CAL.—Bids upon the Brand reservoir have been rejected by the city council, stating that more time was needed for making investigations. The reservoir was designed to hold 8,500,000 gallons.

TUCSON, ARIZ.—Black & Veatch, 307 S. Hill St., Los Angeles, consulting engineers, are preparing plans for a sewage disposal plant involving clarifier and separate sludge digestion tank, estimated to cost $81,400.

FILLMORE, CAL.—Recently voted upon a $10,000 bond issue for the purpose of extending and improving the water system. Many of the old lines are entirely worn out and have served their usefulness.

TACOMA, WASH.—City council decided to lay additional 12-inch water mains in different parts of the city.

KIRKLAND, WASH.—City council plans an additional four-inch water main to supply fire hydrants within the school district.

Applications Filed

Among the more important applications for permit to appropriate water filed with the State Department of Public Works, Division of Water Rights, California, during March, 1927, were the following:

Application 5384 (Merced, Madera and Fresno Counties)—San Joaquin River Water Storage District, care of Harry Barnes, Bank of Italy Bldg., Los Banos, Calif., for 1,000 cubic feet per second from Reservoirs of Southern California Edison Company and San Joaquin Light and Power Corporation, tributary to San Joaquin River. To be diverted in Sections 19 and 20, T 13 S, R 15 E, Section 12, T 11 S, R 13 E, Sections 17 and 26, T 9 S, R 12 E, Section 29, T 13 S, R 16 E, and Section 5, T 11 S, R 21 E, M. D. M., for irrigation purposes on 552,000 acres. Estimated cost $29,732,400.

Application 5378 (San Joaquin County)—Banta-Carbona Irrigation District, Drawer Z, Tracy, Calif., for 5 cubic feet per second from Corral Hollow Creek, Tributary to San Joaquin Watershed. To be diverted in Sections 16 and 14, T 3 S, R 5 E, M. D. M., for irrigation purposes on 5,120 acres. Estimated cost $7,000.

Application 5374 (Sacramento County)—F. A. Wadsworth, Sacramento, Calif., for 2.50 cubic feet per second from Sacramento River. To be diverted in Section 13, T 7 N, R 4 E, M. D. M., for irrigation purposes on 200 acres in Section 13. Estimated cost $2000.

Application 5380 (Los Angeles County)—Ralph Bennett, Central Bldg., Los Angeles, Calif., for 5,000 acre feet per annum from Big Rock Creek, tributary to Antelope Valley Drainage. To be diverted in Section 17, T 4 N, R 9 W, S. B. M., for agricultural purposes. Estimated cost $25,000.

Application 5377 (Contra Costa County)—Town of Walnut Creek, care of E. B. Anderson, Box 6, Walnut Creek, Calif., for 150 acre feet per annum from Walnut Creek tributary to Suisun Bay. To be diverted in Section 35, T 1 N, R 2 W, M. D. M., for municipal purposes. Estimated cost $50,000.

Application 5385 (Modoc County)—Emil Enquist and George Warnmark, Davis Creek Calif., for 400 acre feet per annum from two Unnamed Ravines, tributary to Goose Lake. To be diverted in Section 13, T 47 N, R 12 E and Section 24, T 47 N, R 12 E,

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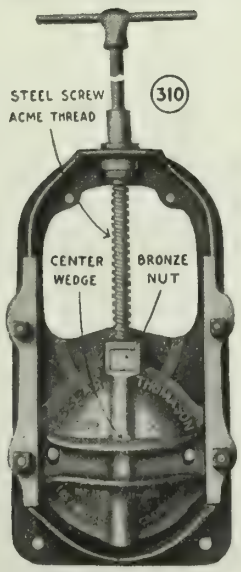

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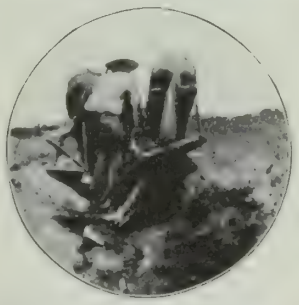

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M. D. M., for irrigation purposes on 236 acres. Estimated cost $2,400.

Application 5386 (Merced County)—Geo. S. Bloss, Jr., care of F. W. Henderson, Atty., Merced, Calif., for 20 cubic feet per second from Duck Slough tributary to San Joaquin River. To be diverted in Section 13, T 8 S, R 13 E, M. D. M., for irrigation purposes on 1625 acres. Estimated cost $10,000.

Application 5387 (San Diego County)—Cromwell D. Eddy and Alvin W. Killam, 1132 20th Street, National City, Calif., for 0.25 cubic foot per second from Spring tributary to Sweetwater River. To be diverted in Section 31, T 16 S, R 2 E, S. B. M., for irrigation and domestic purposes on 20 acres. Estimated cost $1,000.

Application 5389 (San Diego County)—J. N. McLeod, Escondido, Calif., for 1 cubic foot per second from Unnamed Stream tributary to San Pasqual River. To be diverted in Section 26, T 12 S, R 1 W, S. B. M., for irrigation purposes on 25 acres. Estimated cost $750.

Application 5390 (Placer County)—C. O. A. Kempkey, Hobart Bldg., San Francisco, Calif., for 5 cubic feet per second and 1000 acre feet per annum from Ward Creek tributary to Lake Tahoe. To be diverted in Section 23, T 15 N, R 16 E, M. D. M., for irrigation and domestic purposes.

OREGON

Among the more important applications for permit to appropriate water filed in the office of Rhea Luper, State Engineer of Oregon, during March, 1927, were the following:

H. B. Carter, Ashland, Oregon, covering the appropriation of water from unnamed tributary of Bear Creek for the irrigation of 10 acres in Jackson County.

Hugh & Mick Thornton, The Dalles, Oregon, covering the appropriation of water from Artesian Wells for the irrigation of 14.5 acres in Wasco County.

Edna I. MacDougal and Virgil S. Ison, Baker, Oregon, covering the appropriation of underground percolation from the Pine Creek District for the irrigation of 40 acres in Baker County.

G. W. and Ida M. Chapman, Route 2, Salem, Oregon, covering the appropriation of water from an Unnamed spring for domestic use and the irrigation of 5 acres in Polk County, at an estimated cost of $500.

R. W. and Jennie Hogg, Salem, Route 2, Oregon, covering the appropriation of water from an Unnamed spring for domestic use and the irrigation of 5 acres in Polk County, at an estimated cost of $500.

Mr. Arthur C. Perrin, Portland, Oregon, covering the appropriation of 1 second foot from Mollala River for the irrigation of 15 acres in Clackamas County, at an estimated cost of $800.

Mr. M. M. Melvin, Gardiner, Oregon, covering the appropriation of 0.5 second foot from an unnamed tributary of Umpqua River for a municipal supply for the City of Gardiner in Douglas County, at an estimated cost of $1,000.

Mr. A. G. Harvey, Wamic, Oregon, covering the appropriation of .50 second foot from Gate Creek for the irrigation of 40 acres in Wasco County, at an estimated cost of $1,000.

Willie M. Davis, Central Point, Oregon, covering the appropriation of 0.5 second foot from Kanes Creek for the irrigation of 30 acres in Jackson County, at an estimated cost of $250.

Chas. H. and N. Frances Long, Salem, Oregon, covering the appropriation of .5 second foot from Johnson Creek for the irrigation of 8 acres in Clackamas County, at an estimated cost of $200.

Permits Issued

Among the more important permits to appropriate water issued by the Department of Public Works, Division of Water Rights, California, during March, 1927, were the following:

Permit 2735, Application 4959 (Butte County)—Issued to The Gray Lodge Gun Club, Sacramento, Calif., March 8, 1927, for 15 cubic feet per second from Hamilton Slough and Lateral "C" of Reclamation District 833 in Sections 2, 10, 11, T 17 N, R 1 E, for irrigation of 2184 acres near point of diversion. Estimated cost $10,000.

Permit 2738, Application 5215 (Santa Cruz County)—Issued to City of Santa Cruz, Santa Cruz, Calif., March 10, 1927, for 25 cubic feet per second from San Lorenzo River in Section 12, T 11 S, R 2 W, for municipal purposes in Santa Cruz and vicinity.

Permit 2741, Application 5236 (San Diego County)—Issued to Mrs. R. Silva, El Cajon, Calif., March 11, 1927 for 0.15 cubic foot per second from Los Cochis Creek in Section 13, T 15 S, R 1 E, for domestic use and irrigation of 12 acres in Section 13. Estimated cost $1500.

Permit 2743, Application 3364 (Solano County)—Issued to Geary Rich, San Francisco, Calif., March 15, 1927, for 356 acre feet per annum and 10 cubic feet per second from Lindsay Slough in Section 19, T 5 N, R 2 E, for municipal purposes in Cordelia, Vallejo, Benicia, Suisun, Fairfield and adjacent territory in county of Solano. Estimated cost $2,000,000.

Permit 2756, Application 5317 (Mendocino County)—Issued to Lloyd F. Cook, Hartsook, Calif., March 29, 1927, for 0.62 cubic foot per second from South Fork of Eel River in Section 24, T 5 S, R 3 E, for domestic use and irrigation of 50 acres in Section 24. Estimated cost $200.

Permit 2758, Application 1987 (Stanislaus County)—Issued to West Stanislaus Irrigation District, Westley, Calif., March 29, 1927, for 262.15 cubic feet per second from San Joaquin and Tuolumne River in Section 10, T 4 S, R 7 E, M. D. M. for irrigation of 20,972 acres within said district.

San Gabriel Flood Control Report Issued by Board

(*Continued from Page 49*)

square miles. Storage capacity will be provided to the extent of 1025 acre feet. The combined discharge capacity of outlet and spillway, as now planned, is 325 second feet. From this drainage area, a flood with a maximum daily discharge of 2,500 acre feet is to be expected, in which case, even with this reservoir entirely empty at the beginning of the period, the flood would fill the basin, exceed the combined outlet and spillway capacities, and a part of it will necessarily overtop the dam. With the reservoir full or nearly so, at the beginning of the maximum day, the situation would be still more serious. A revision of the

plans should be made before this work is undertaken. To build the dam in accordance with the present plans would not be safe.

Type of Flood Peak Used

In all of these studies on the smaller drainage areas, a type of flood peak has been used similar to the one recorded for Arroyo Seco during the storm of February, 1914. Maximum peak discharges are estimated on the basis of from 400 second feet per square mile for areas of 25 to 40 square miles to 600 second feet per square mile for the smaller areas of 3 to 5 square miles. There is ample justification for such assumptions. Already there is a record of 367 second feet per square mile from Eaton Canyon drainage area. If figures were to be accepted as large as those suggested by the Chief Engineer of the Flood Control District in some of his communications, the inconsistency of the plans for many of these storage units would be all the more noticeable.

The Chief Engineer has repeatedly announced as his policy "dams are proposed to the maximum heights which I thought the physical conditions offered for safe construction, and of course these heights govern their capacities." The general carrrying out of the project to date squares up with that policy. It is not based on sound engineering principles and as would be expected, it results in expenditures of doubtful value, and in some structures of doubtful safety. It is a serious matter to build a dam in a canyon subject to heavy floods, without a careful study of flood conditions to be expected, and without ample provision for taking care of maximum probable floods.

In several of the cases already mentioned, the flood menace to the structures obviously has been overlooked: for example, at San Dimas, Puddingstone, and the proposed dams on Big Dalton and Thompson Creek. Dangerous conditions exist which should be remedied at once.

The Board of Supervisors, in the opinion of the Consulting Board, has suffered from poor engineering advice as to a coordinated plan for the San Gabriel Flood Control Project. Large sums have been expended which, in our opinion, could have been used to much better advantage. By proper engineering and economic studies of future plans, before construction is undertaken, a repetition of such mistakes may be avoided.

Respectfully submitted,

F. H. Fowler,
Chas. D. Marx,
Chas. H. Paul,
Consulting Board.

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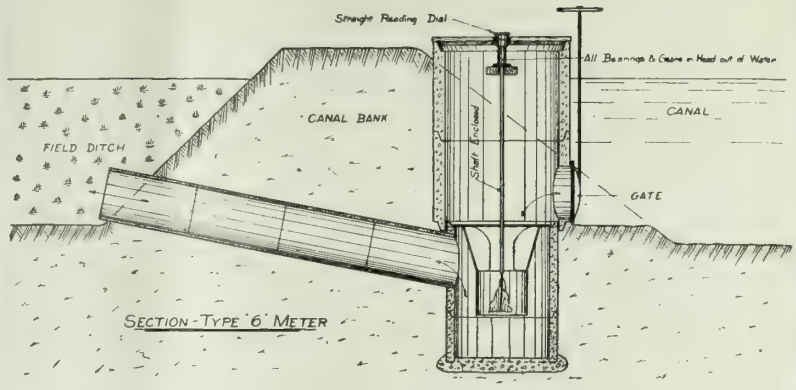

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WHO'S *WHO* AND WHO'S *WHERE*

IN THE WORLD OF HYDRAULICS

Personal Notes and Impersonal Observations About Men You Know

T. H. King, engineer of the La Mesa Irrigation district, has been elected president of the San Diego Section of the American Society of Civil Engineers.

W. C. Paul, of Rupert, Idaho, president of the Minidoka irrigation district, recently visited the Washington office of the bureau of reclamation.

R. F. Walter, chief engineer of the bureau of reclamation, recently made an inspection trip covering the Boise, Vale, Owyhee, Gooding, Minidoka, American Falls, and Salt Lake Basin projects.

William K. Reed, civil engineer, Sacramento, California, has been appointed city engineer of North Sacramento, succeeding John N. Bidwell, who resigned to go into private engineering practice.

Barry Dibble, consulting engineer of Redlands, California, and formerly superintendent of the Minidoka project, Idaho, paid a recent visit to the Washington office of the bureau of reclamation.

J. B. Brown, of the University of California, in connection with the Farm Advisor's office, staged three demonstrations of alfalfa irrigation in Imperial Valley during the latter part of March.

P. E. Weymouth, formerly chief engineer of the United States reclamation service, was in Brawley, California, during April, for a conference with M. G. Dowd, engineer of the Imperial Valley irrigation district.

C. C. Ketchum and D. J. Paul, assistant engineers, have been transferred from the Boise to the Vale project. Charles G. Anderson, junior engineer, has been transferred from the Vale to the Boise project.

Ira C. Robinson, of La Mesa, California, has been elected president of the La Mesa, Lemon Grove and Spring Valley irrigation district. Mr. Robinson is also entering on his third year as one of the directors of the district.

E. E. Roddis, of Billings, Montana, district counsel of the bureau of reclamation, spent several days on the Shoshone project recently, working out a plan for the operation of the works common to the Deaver and the Shoshone irrigation districts.

William Mulholland, chief engineer and general manager of the Los Angeles Water Bureau, has been invited to act in an advisory capacity to the city officials of Fresno in the contemplated purchase by Fresno of its water supply system. It is said that the purchase price involves approximately $2,500,000.

W. L. Powers, chief in soils at the Oregon Agricultural College, and Walter Holt, Umatilla County agent, visited the McKay dam on the Umatilla project in March and went over the distribution system. More than 10,000 acres of new land are to come under irrigation on this project for the first time this spring.

William F. Durand, of Stanford University, recently named by Dr. Hubert Work, secretary of the interior, as California's representative on the Colorado river commission, has gone to Washington after conferring on the official stand he is to take with regard to the Colorado river situation when he meets the other commissioners in Yuma on April 29.

M. J. Dowd, chief engineer of the Imperial Irrigation District, was the principal speaker at the semi-monthly meeting of the American Conservation Club, held in El Centro, California, the latter part of March. Mr. Dowd gave a report of the preliminary survey made by the district on their canals as to the feasibility of power generation within the boundaries of the district.

H. C. Neuffer, assistant engineer on the Coolidge dam, who is now in San Carlos, Arizona, working on the many details of the design, spent several days in Los Angeles during the latter part of March. Mr. Neuffer states that work is progressing favorably upon the project, and that the contractors, Atkinson, Spicer and Company, now have three steam shovels excavating for the spillways and dam.

Arthur Powell Davis, former director of the U. S. Reclamation Service and now chief engineer of the East Bay Utilities Company, represented the Imperial Irrigation District at the dinner given by the California Water Resources Association in San Francisco recently. The district was invited to send a representative to talk on the Boulder Dam project.

Francis Cuttle, of Riverside, was the principal dinner speaker at the March meeting of the Los Angeles Chapter of the American Association of Engineers. Mr. Cuttle, who has been president of the Tri-Country Water Conservation Association, of San Bernardino, Riverside and Orange Counties, since its organization, spoke on the "Water Resources of California."

Donald M. Baker, consulting engineer of Los Angeles, national second vice-president of the American Association of Engineers, discussed the Herminghaus decision of the California supreme court and gave a brief resume of the western water law leading up to this famous case before the March dinner meeting of the Los Angeles Chapter of the Association.

Secretary of the Interior Hubert Work has appointed a Colorado River Commission as follows: Senator Charles W. Waterman, Colorado; James R. Garfield, former secretary of the interior; Governor Frank C. Emerson, Wyoming; James G. Scrugham, former governor of Nevada; and Professor William F. Durand, of Stanford University, California. In a letter addressed to the commission Secretary Work asked that the members meet with him and Dr. Elwood Mead, U. S. commissioner of reclamation, in Yuma, Arizona, April 29.

MODERN Irrigation

The Magazine of Applied Hydraulics

Vol. III MAY, 1927 No. 5

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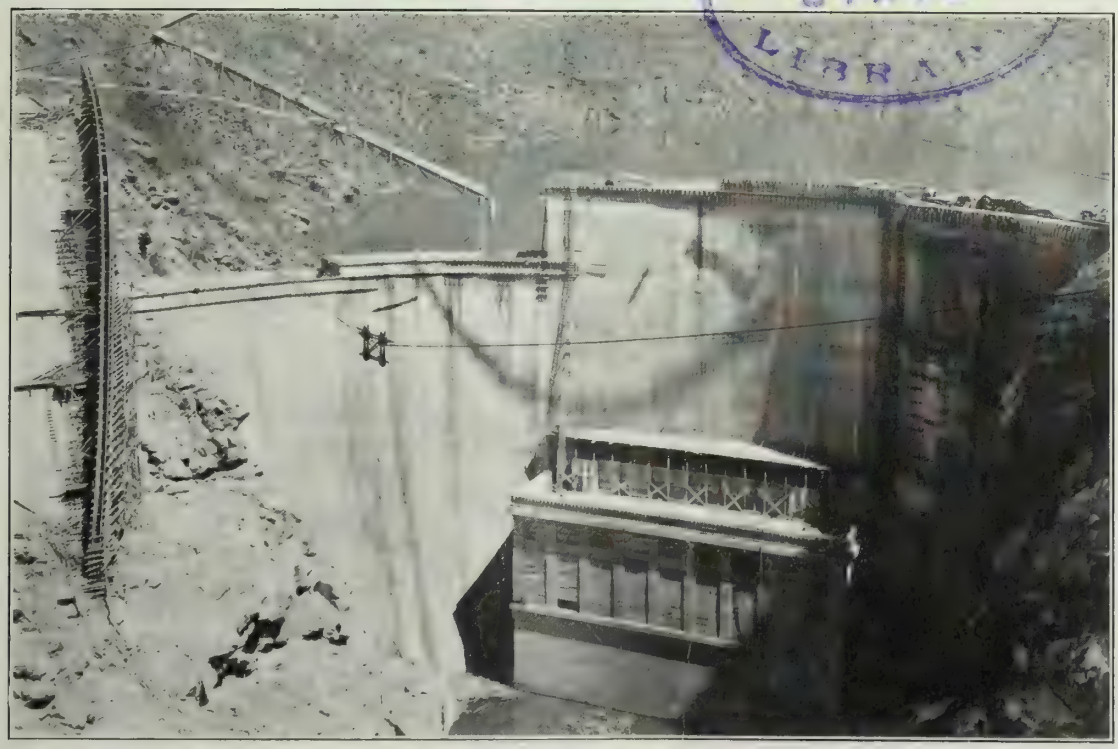

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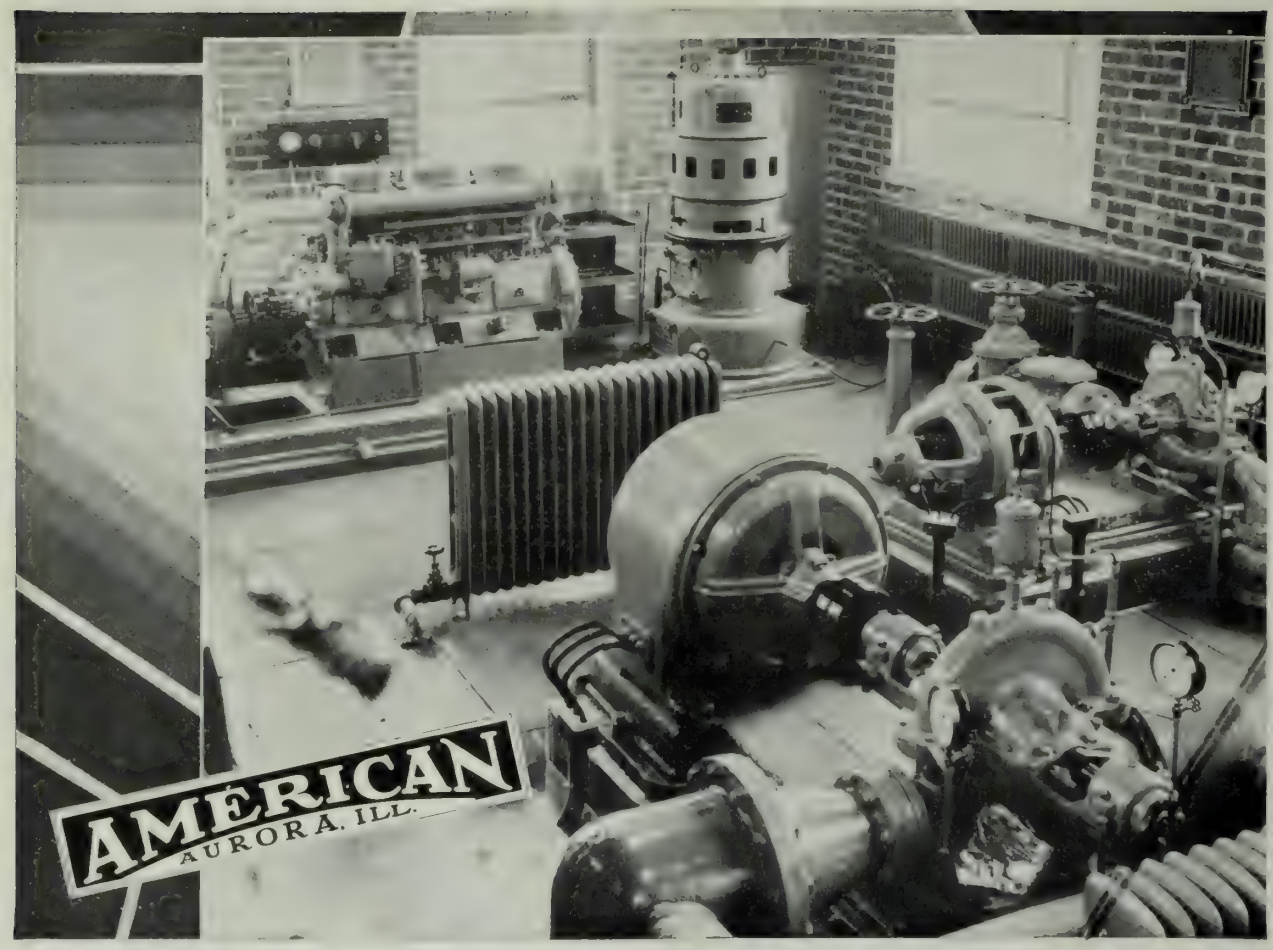

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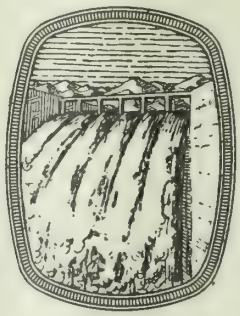
"Western Waterworks" Begins on Page 25

A. W. CUDDEBACK

President of the American Water Works Association which holds its 47th annual convention at Chicago from June 6 to 11. Plans and arrangements for the convention program and entertainment are nearing completion and the six-day meeting promises to be a memorable one in the history of the association. Mr. Cuddeback is vice president of the Federal Water Service Corporation, New York City.

MODERN Irrigation
The Magazine of Applied Hydraulics



Volume III MAY, 1927 Number 5

The Progress *of* Irrigation

THE past few weeks have witnessed marked progress in dam construction on the various irrigation projects of the West. The Bureau of Reclamation has completed two big dams which are remarkable not only for the acreage they open up to irrigation—30,000 acres in one case and 1,000,000 in the other—but also for the fact that they were built for considerably less than the estimated cost.

On Tuesday, May 10, the McKay dam, near Pendleton, Oregon, was formally dedicated by Governor Patterson and Dr. Elwood Mead, commissioner of the Bureau of Reclamation. The McKay dam was built at a cost of $2,500,000, which broke the bureau's construction records by being $200,000 under the estimated cost. Two years and a half were required to complete the structure. The dam is 165 feet in height—one of the highest earth-fill dams in the United States,—2860 feet long, 90 feet wide at the base, and 24 feet wide at the top. Its capacity is 73,662 acre feet.

The project will furnish water for the Stanfield, Westland and Hermiston districts in the west end of Umatilla county. Approximately 30,000 acres will benefit directly from the allotments of water already made from the McKay reservoir, and a large additional acreage will benefit from the drainage back into the Umatilla river from these lands. This drainage water is picked up by the government's west extension canal and applied to lands in the Irrigon and Boardman districts. With more than one-third the capacity of the reservoir still unallotted, additional acreages of raw lands will be brought under reclamation when the exact requirements of the lands are definitely determined by actual irrigation over a period of several years.

On April 20 the American Falls dam, Idaho, was completed and turned over by the contractors, more than two months earlier than the date required by the contract. As completed, the dam is 5,227 feet in length, 83 feet in height at its highest point, and 75 feet in width at base. The reservoir above the dam is 25 miles in length and has an average width of three and one-half miles. It has a shore line of 125 miles, and is the second largest body of water of its kind in the United States—larger than the famous Roosevelt reservoir on the Salt river in Arizona, and being exceeded only by the Elephant Butte reservoir in New Mexico. It is Idaho's greatest body of water, being much larger than Lake

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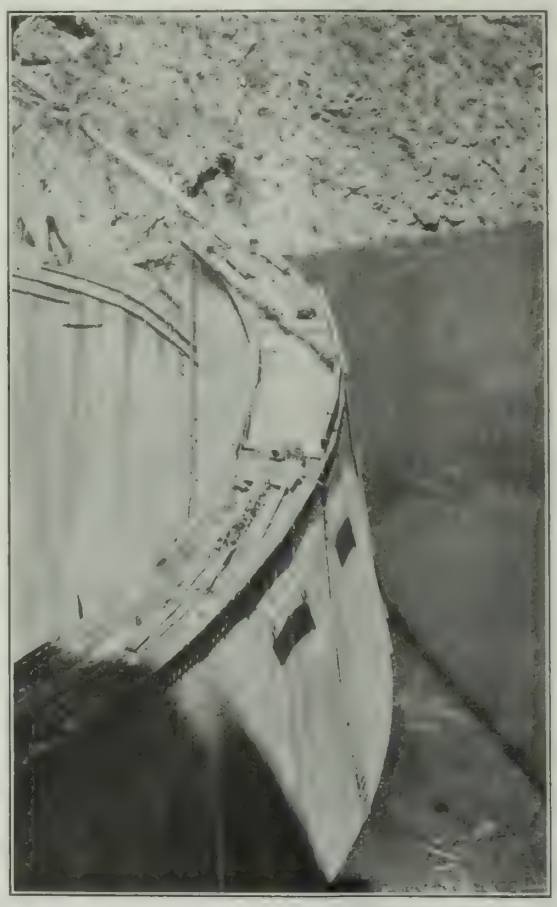
Coeur d'Alene or Pend Oreille, and almost as large as the two together.

In preparation for its first season of operation, the gates of the dam were closed on October 31, 1926, and all winter long the flow of the Snake river has varied from 4,000 to 10,000 feet daily. Enough water has been released to fill Lake Walcott reservoir, having a capacity of 106,000 acre feet, and on April 9 American Falls passed the half-way mark, recording 850,000 acre feet. The reservoir is expected to fill to capacity by June 30. With an unusually heavy blanket of snow on the watershed, it is believed that some 500,000 to 750,000 acre feet of surplus will flow over the spillways this year.

Of the 1,700,000 acre feet of storage that will be contained in the reservoir, supplemental water rights will be furnished to 1,000,000 acres of land, both above and below the dam. Approximately 500,000 acre feet will be retained by the government, and can be used for new projects, among them the Shoshone project, the Minidoka extension, the Empire district, and the Greater Fort Hall project, the latter tributary to American Falls and part of it under irrigation.



Even though the Horse Mesa Dam, near Phoenix, Ariz., is not fully completed, water is being stored for summer use, and the hydro-electric plant is in operation. The photograph shows the water backed up against the dam with construction in progress.

Plans for the construction of a fourth great reservoir and power dam across the Salt River, at Stewart Mountain between Mormon Flat and Granite Reef diversion dam, Utah, have been prepared by engineers of the Salt River Valley Water Users Association, and authority to construct the dam under a refenue bond financing plan will be submitted to members of the association early this fall. The Stewart Mountain dam would be the fourth major dam in the Salt River series. The first dam, the Roosevelt, was built highest up the river and furnished flood control while the others were being built. The other dams are the Mormon Flat (Canyon Lake) and the Horse Mesa which it is said will be named in honor of Governor Lowden of Illinois.

"The Horse Mesa development," said F. A. Reid, president of the association, in his annual report on May 2, "is now nearing completion and is in operation earning a substantial profit for our farmers each day. The gross revenue of this new development for the month of April exceeded $80,000, or nearly $50,000 net profit above interest, depreciation, operation and maintenance. On April 28 the power system shows 745,100 KWH generated during the 24 hours. Previous to the starting of the Horse Mesa plant the highest day's output for April was 395,460 KWH, or but little over half the present. By the end of this month the Horse Mesa development will be earning over $4,000 per day and with the exception of some unforeseen delay or minor item will be entirely completed and paying dividends in the form of reduced water assessments."

The proposed Stewart Mountain dam project will entail an expenditure somewhat less than that at Horse Mesa, and will generate approximately the same amount as the Horse Mesa plant. Although definite announcement of the details of the financing plans has not been made, it is said that a group of capitalists have offered to bear all expenses for constructing the dam, trusting to the proven ability of this kind of project to yield handsome returns and assure payment. If this plan is adopted it will mean that the dam can be constructed without any financial outlay on the part of the Water Users Association —without any assessment and without the necessity of asking for federal aid.

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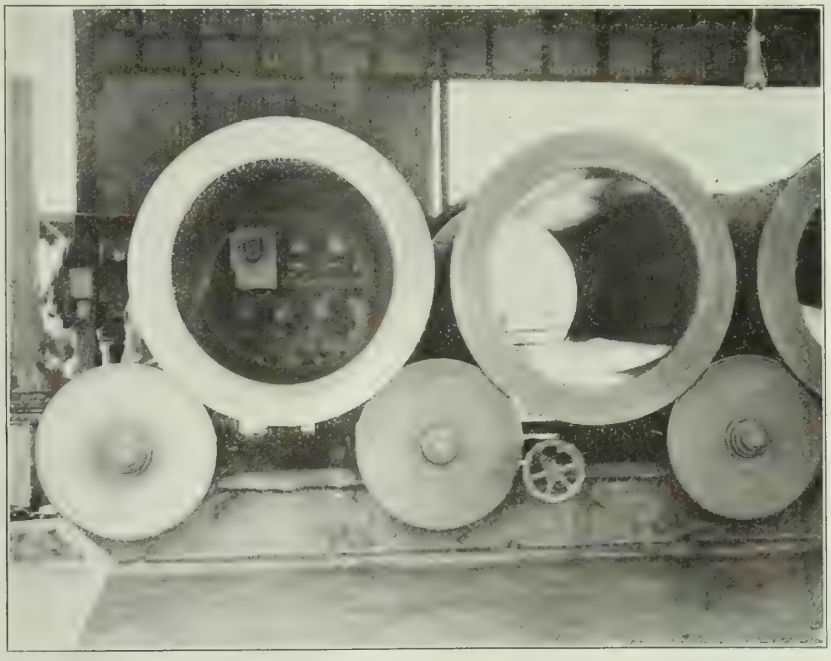
Unique Method of Making Concrete Pipe by Centrifugal Force

Gives Product Which Is Nearly as Dense as Marble; New Line Is Being Installed Near Riverside

By GRAYDON OLIVER

A RECENT graduating class from one of our well known scientific schools was given the definition of the word engineering as "harnessing the forces of nature to perform useful work for the benefit of civilization." This is a very decisive definition, and we find, in this modern age, that the forces of nature are being harnessed in every possible way. A rather striking example of this has recently been applied to the concrete pipe industry and is proving a benefit to the waterworks and irrigation industries of this country.

Concrete pipe, with its advantages and disadvantages, has long been known, and hydraulic engineers in all parts of the world have recognized its great value for certain classes of work, but to see concrete pipe made in such a manner that it becomes as desirable as cast iron or steel pipe for nearly all classes of work, is something that heretofore has been unthought of. This has been made possible by the proper utilization of centrifugal force, spinning a plastic concrete cylinder, until the density of the mass nearly approaches that of marble.



Centrifugal pipe is made by spinning the pipe at relatively high speed. The above photograph shows the machine upon which this pipe is rotated. Four eight-foot lengths of pipe are rotated simultaneously, and it can be seen that a glaze is imparted to the interior surface during this process.—Modern Irrigation photo.

Is Australian Invention

The centrifugal process was invented by Hume Brothers, of Adelaide, Australia. We are told that it has been used quite successfully in Australia, South Africa, and England, ever since its introduction three years ago. One English firm manufactures both concrete and iron pipe by the centrifugal process, but the English have not developed the concrete product to the extent that has been done in Australia and South Africa. In these latter countries, centrifugal concrete pipe has been widely used for all classes of pressure lines, and in a great many cases, is regarded as superior for certain classes of work.

American engineers have been rather slow in adopting this new method, and only recently have there been any important installations here on the west coast. The first of these important jobs was the Laguna Beach pipe line, a pressure line built to handle the water supply to Laguna Beach and adjoining communities. The second important installation is now under construction near Riverside, California, and will be the main water supply line for the city of Riverside, running from the artesian water farm, approximately seven miles east of the city, to the distribution system of the city of Riverside. It is this later installation that is attracting the most attention, because of its larger diameter and because it has been designed to work under considerably more difficult conditions.

Process Described

The manufacturing process is comparatively simple. Steel forms of the proper size are used, and these have retainer rings bolted thereto, at each end. The rods holding these rings in place run on the outside of the forms, and clamp one ring to the other. These rings are made of cast iron, and are so designed that their exterior surface acts as the turning surface upon which the cylinder is rotated. This is better illustrated in the accompanying photograph, which shows the cylinder, set upon the rotating discs, and being turned at full velocity. The cylinder is placed between two driving discs, upon which it rests, and which are driven by exterior power. The friction between the discs, and the rings is sufficient to rotate the cylinder at its full velocity. The machine is so made that it will accommodate four cylinders, all of which are rotated simultaneously.

The length of time that the material is spun depends entirely upon the weather and working conditions. After the material has been distributed evenly inside of the form, and smoothed down into the reinforcing cages by hand, the cylinder is spun for about four or five minutes. This compacts the conglomerate into its approximate position. The centrifugal force has a greater effect upon the heavier constituents than it does upon the light weight particles, so the conglomerate is compacted against the side walls of the container, while the surplus water, bits of wood and laitance, or other foreign particles, remain upon the inner surface of the pipe. After five to eight minutes of rotation, the machine is stopped, and this surplus water or other material, is brushed out. The unused and expelled water taken out during this operation is free of all cement, and the voids in the aggregate have been filled with the binding material in a manner never before attained by any of the old methods of

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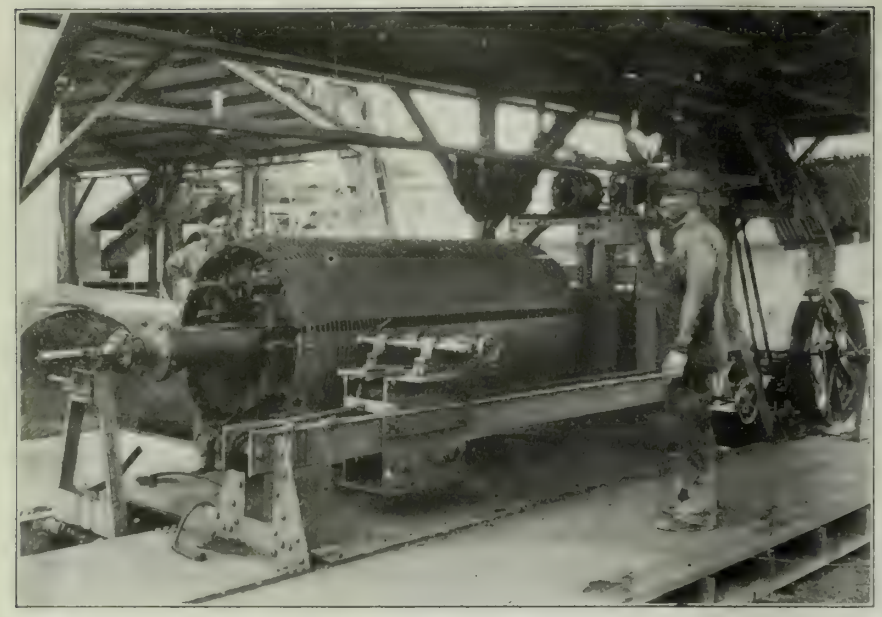

The re-inforcing cages are made on a specially constructed machine, which is shown above. At the right is a smaller machine which makes the cages for the collars, and at the left rear are some of the finished cages.—Courtesy Western Concrete Pipe Co.

pipe manufacture. The speed of rotation is approximately 320 r.p.m.

After cleaning the interior surface, the pipe is again spun, the second operation lasting about three minutes. The period of operation depends entirely upon the weather conditions, and the working conditions of the material that is being used in the conglomerate. The aggregate is compacted so closely and finely against the sides of the container, that when the operation is completed, it will be found impossible to make an indentation on the interior surface with the thumb or finger, as is the usual method of testing the hardness of the concrete. In fact, the pipe at this stage is quite comparable in hardness to ordinary pipe after it has been cured, because a mechanical set has taken place during the spinning.

The second spin imparts a glaze to the interior surface similar to the troweled surface of a well laid concrete sidewalk. It is the final glaze that gives this type of pipe its extremely low friction coefficient when in use. After the completion of the second spin the pipe, still in the forms, is moved to a steam room, and allowed to remain for twelve hours in a warm saturated atmosphere of about ninety degrees Fahrenheit. After leaving the steam room, the pipe is taken from the forms, and kept wet under canvas for three days. The total curing period requires approximately fourteen days, the pipe being kept moist during the entire period, at the end of which time it is hauled to the job, and immediately placed in the ditch.

Density of Pipe

The centripetal force acting upon the different material of the conglomerate creates a quite heavy pressure. In ordinary materials we find the following densities:

Ordinary Rock	125	lbs. per cubic foot.
Ordinary Sand	100	do
Portland Cement	98	do
Water	62.5	do

A body moving with constant speed v, in the circumference of a circle, is acted upon by one force, the normal or centripetal force, and this equals $\frac{Mv^2}{r}$. That this is true is evident when it is remembered that the tangential velocity is constant, thus making the tangential acceleration zero. Using the above densities of the materials listed, we find that the following pressures are exerted upon the outer casing of the form, when the mass is rotated at the speed of 320 r.p.m.

Rock	30.7	lbs. per sq. in.
Sand	28.2	do
Cement	22.0	do
Water	17.5	do

As the mass is compacted, we find that the densities are increased, owing to the filling up of the voids, and in the finished product, there is a density of nearly 155 pounds per cubic foot, which was created under a pressure of 45 pounds per square inch. It can be readily seen that an interior pressure as great as 45 pounds per square inch will compact the material in a manner never before done, and in fact, the mass approximates the density of marble.

Method of Reinforcement

This new product is being made both with and without reinforcement. The reinforcing material is No. 8 cold drawn steel wire, and is placed in the pipe in the form of cages. The tensile strength of this wire is computed upon the basis 16,000 pounds per square inch, using a safety factor of four or five. A special machine has been designed and built to construct these cages, a photograph of which is shown. These cages are more or less flexible, but are so wound that they have a definite exterior diameter. When placed inside of the forms, and spun together with the conglomerate, the centripetal force automatically centers the steel in the wall of pipe, while at the same time it is placed under a tension. This can be readily seen. The well known shrinkage of the concrete from the reinforcing material seems to be obviated in the manufacture of this type of pipe, for the reason that the mechanical set of the conglomerate takes place while the centripetal force is acting upon the steel and concrete simultaneously.

In making this type of pipe it has been found through experience that clean, coarse, sharp sand gives the best results. It should not contain over 4 per cent of silt and loam by decantation, or more than 4 per cent of the material passing through a 100 mesh screen. Gravel larger than ⅜ inch is not desirable on account of the type of reinforcing material used. The mixture that is in common use at the present time is 1:2.3;1, which calls for 158 pounds of aggregate including moisture content. This is on the basis of 10.35 sacks of cement to a cubic yard of concrete in place. In regard to the water content, as little water as possible makes the best mixture. Numerous slump tests which were conducted during the early stages of the work varied from nothing to 3½ inches, but the results of the internal hydrostatic tests on the pipe showed that

The collars are properly centered on the pipe and neat cement used in caulking. This process takes place within four or five days after the pipe is turned out of the machines. —Staff photo.

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the lowest slump tests give the best results. The water ratio was decreased until the mass would pile up in the skip and would not show a perceptible slump, and after spinning nearly half of the orginal is expelled.

During the early stages of experimentation all kinds of reinforcing materials were tried out. Some of the first pipe made was reinforced by cages made of flat spacing bars. This bar proved to be a detriment to the placement of the concrete by this system of manufacture. Because of the centripetal force created during the spinning operation, the concrete in front of and against this flat spacing bar thrust it outward against the form, thus deforming the cage from a true circle, and set up a strain which encouraged fracture of the concrete along the outer side of the pipe on the lines of the bars. The bars were so wide that they interfered with the packing of the mass directly in back of them, and the density of the whole mass was

The finished product is held in the curing yard until ready to take out onto the line. During this period of its manufacture it is kept wet so that the concrete is properly cured.—Staff photo.

greatly impaired, so that the pipe on hydrostatic tests showed porosity. This flat bar type of reinforcing was discarded in favor of the Tripple spiral type which has already been described, and which has proved to be a positive success.

Results of Tests

In making tests upon this type of pipe, the hydrostatic test has proved to be the best. It has been found that standard run pipe, 14 to 16 days old, which was designed for 125-foot heads, withstood 250-foot head. One section that was made for only 50-foot head was brought up to 195-foot head before it failed. While the Laguna Beach pipe line was being laid, tests were conducted daily at the manufacturing plant, and practically all of the pipe tested withstood twice the pressure for which it was designed. It was the general custom, however, to test the pipe to 150 per cent of the line pressure, and in every case this was attained without any seepage whatsoever. The engineer's report on this job showed a joint of 27-inch pipe withstanding a pressure of 110 pounds per square inch without seepage, indicating a unit tensile strength in excess of 400 pounds.

External top load tests were also conducted, and in all cases were highly satisfactory, there being no fractures under the specified test. Several sections, however, were brought to a point of failure, one being a 27-inch diameter section with a wall thickness of 2⅝ inches, designed for a 50-foot head, which was 23 days old. The specified test upon this pipe was 26,400 pounds, and was brought to failure at 33,800 pounds, when it showed slight cracks at each end in the bottom only. The spring lines were not affected. This particular section was then placed in a hydrostatic testing machine and subjected to an internal pressure of 32½ pounds for twenty minutes without showing any signs of seepage.

In all the cases where tests were conducted to failure, none of the reinforced pipe fractured the full length, or even cracked so that the water gushed or squirted out as is common in failures of concrete pipe. Very minute longitudinal cracks, which were so tiny that they were scarcely visible, appeared at various points in the circumference at one or both ends, and as the water pressure was maintained at comparatively high value, the water filtered through very slowly. From the tests that have been conducted by various interested parties and the manufacturers, it is evident that the value of the reinforcing material is obtained long before the failure of the pipe, and the extreme hydrostatic tests that were carried on indicate that there is a positive bond existing between the reinforcing material and the concrete.

Laguna Beach and Riverside

As previously stated the first important installation of centrifugal cast pipe was made for the Laguna Beach Water District, near Laguna Beach, Orange County, California. This line was approximately 17,000 feet long, and centrifugal cast reinforced concrete pipe of sizes from 18-inch to 27-inch diameters were used on heads varying from 25 feet to 125 feet. The pipe line is now under very successful operation, and the total loss of water is much under the requirements. J. B. Lippincott & Company of Los Angeles, California, acted as designing and consulting engineers upon this particular installation.

The pipe line that is now under construction near Riverside, San Bernardino County, California, is approximately 35,320 feet in length, and is one continuous syphon for its entire length. The

Laying the pipe in the ditch. This process is described in detail in the accompanying story.—Staff photo.

diameter of the line is all 42-inch, and designed to accommodate 20 second feet with a maximum differential head of only 15 feet. The designers of this line, Reaburn & Bowen, consulting engineers of Los Angeles, used the Scobey formula for concrete pipe, the coefficient C being 0.0345, in the formula:

$$V = CH^{0.5}\, d^{0.625}$$

This low value was made possible because of the extremely smooth interior surface of the pipe. The manufacturers express their belief that a work coefficient of 0.400 will be attained in the final tests.

Experience is the greatest of teachers, and the manufacturers have been gaining much experience ever since their first experimentation with the pipe. They have vastly improved the methods of laying, eliminating all of their previous difficulties, and at the present time are able to lay an absolutely watertight line, which has a perfectly smooth interior surface. The method of laying is quite interesting, and is briefly described.

Laying the Pipe

The pipe is brought from the pipe yards in just sufficient amounts to supply the workmen placing it in the ditch, so that it is not allowed to become sundried and overheated. All collars are placed upon the joints before they are brought to the field, this being an operation which takes place during the first five or six days of the curing. These collars have an opening 1¼x1 inch through which the grout is poured when laying the finished joint. In placing in the ditch, all joints are laid to grade and line. The

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Success of Irrigation Projects Demands that Development Keep Pace with Construction

Second Land Economics Conference Stresses Need for Study of Project Feasibility before Construction is Decided

By ROSS H. GAST

THE BROAD and complex subject of irrigation construction and its relation to agricultural development in all its phases was given a thorough airing at the Second Land Economics Conference, called by the University of California, and held at the Los Angeles Chamber of Commerce, April 25-26. This meeting brought together experts on irrigation, irrigation district financing and land settlement from all parts of the west, and while much dirty linen of reclamation and colonization was washed, no recommendations as to future policy were advanced by the conference as a body. It was emphasized by several speakers, however, that there is a necessity for closer study of project feasibility from an economic standpoint before irrigation construction is considered. This, it was pointed out, will result in a higher percentage of success in irrigation projects and finally work toward the lowering of financing costs of such construction.

At the morning session, April 25, R. N. Wilson, Director, Agricultural Department, California Development Association, presided, and after opening the meeting he presented Dan F. McGarry, President, Los Angeles Chamber of Commerce, who made a few introductory remarks. The remainder of this session was given over to Professors Charles West and David Weeks, Division of Agricultural Economics, University of California, with discussion led by O. V. P. Stout, Division of Irrigation Engineering, United States Department of Agriculture. The university experts presented strong papers on the problem of securing closer relationship between irrigation construction and agricultural development, the material coming as a result of four years' study of the economic situation in California irrigated areas.

This dual paper really sounded the keynote of the conference, and the underlying causes of the situation as revealed by these studies were carefully discussed.

Development Lags Behind

The general theme of the Weeks and West papers was the lack of synchronism between irrigation construction and agricultural development. The experts brought out the fact that since 1920, the rate of construction has decreased and so has the settlement of land, but not so fast. It was estimated that in 1924 there were 1,200,000 acres of undeveloped land in California provided with irrigation equipment which were not using the water. Of the irrigated area,

Bert R. Holloway

Chairman, Agricultural Department, Los Angeles Chamber of Commerce and one of the presiding officers of the Second Land Economics Conference held at Los Angeles in April.

750,000 acres were only partly prepared for irrigation; only two-thirds of the irrigable area was making full use of the water and 20 per cent was making no use whatever of the construction installed. The increase in the irrigated area of California from 1919 to 1924 was estimated at 500,000 acres, and the University men declared that if future settlement of irrigated lands takes place at the same rate as it has during the past five years, it will take from 15 to 20 years to develop all the land for which irrigation construction has already been provided. The reasons for this lag between the date of construction and utilization of water were also discussed in detail by various speakers.

Professors Weeks and West also declared that industrial conditions affect greatly these two important phases of irrigation development and that there is an inversed relationship between irrigation construction and agricultural development. Settlers move to lands during periods of depression while irrigation works are constructed during periods of prosperity. Other factors which tend to increase the lapse of time between irrigation construction and agricultural development are that the total cost of development often exceeds the expectation of farmers and even under the most favorable conditions, capital requirements of development are greater than amounts possessed by settlers. Over-production may be one of the causes of retarded development, but this factor was qualified by the statement that there is still opportunity for farm development by good farmers on good lands of a sufficient unit size, if the endeavor is adequately financed.

Feasibility Important Point

The whole discussion of the subject of bringing about proper relationship between irrigation construction and agricultural development focused attention on the importance of the proper determination of project feasibility. The spectre of the 30 years of activity by Reclamation Service in irrigation development in the west was flaunted before the conference by several speakers and their record, which, in a way, has been a record of failure resulting in the writing off of twenty-seven millions of dollars, was shown to be one of the most convincing arguments for better determination of project feasibility, especially its economic aspects.

The afternoon session of the first day's meeting, presided over by B. R. Holloway, Chairman of the Agricultural Committee of the Los Angeles Chamber of Commerce, first heard a paper on the farmer's viewpoint and the relationship between irrigation and agricultural development, assigned to Earle Houghton, president of the California Farm Bureau Federation, but read by Alex Johnson, secretary of that organization. The discussion of this subject was by Frank T. Swett, president of the California Pear Growers' Association. The idea advanced in these two papers was the necessity of checking a development and

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"What Determines the Price and Interest Rate on Irrigation District Bonds?"

Intrinsic Security of Bonds and Conditions Affecting Marketability are Cost Factors to be Considered

By C. J. THORSON*

THIS outline is confined to irrigation districts located within California, as the statutes of the various states and the economic conditions of irrigation district development differ so widely, with a corresponding effect upon the comparative intrinsic security and marketability of bonds issued within the different states.

Also, it is my understanding that my remarks should supplement the other addresses scheduled upon this program, which are expected to outline the basic requirements of well conceived irrigation districts in California and the financing thereof. Consequently I will endeavor to confine my discussion to those features which affect the marketability of California irrigation district bonds, for after all it is the marketability that, in the last analysis, directly affects the interest rate and price paid by the investment banker for the bond issue.

It occurs to me that the subject lends itself to analysis from two rather well defined viewpoints—first, the factors establishing the intrinsic and potential security of the bonds, and—second, the conditions affecting marketability of the bonds after the fundamental security thereof has been satisfied.

Factors Determining Value

Let us then first outline the features of an irrigation district and its financing, which affect its bonds from an abstract investment standpoint:

(1) *Conditions Existing at the Time Financing is Undertaken:* Under this heading such analysis as the following would be classified:

History of the district—the extent of *agricultural and water development.*

Crops—Past profits realized per acre from the various uses made of the land.

Size of the district and irrigable acreage.

Location, with reference to markets, source of water supply, cities, schools, recreational advantages, etc.

Soil conditions with special reference to the economic results following years of cultivation.

Established *supply of water* as to amount, season, location, whether surface or underground, riparian or appropriated, stream flow or flood run-off.

Water storage, amount developed, amount capable of development, seepage, evaporation, cost of development including canals and laterals.

Land owners, resident or non-resident, nationality, number and average acreage of holdings, nature and extent of land improvements.

Past financial record of the district, particularly as to prompt payment of interest and principal, default, tax delinquency.

C. J. THORSON

Mr. Thorson, as treasurer of the California Bank, Los Angeles, is in constant touch with irrigation and reclamation developments throughout the west, and is considered an authority on district financing.

Tax budget, the economy of its administration, etc., etc.

Of course the need, purpose and feasibility of the improvement for which the financing is being undertaken should be approved by professional reports from engineering, agricultural, appraisal and legal experts.

(2) *Potential Economic Possibilities of the District:* Oftentimes areas can be found where some agricultural development has been in progress for a number of years but on a very desultory basis with correspondingly limited results—results which, if solely used in analyzing proposed bonds of such an irrigation district, would probably cause the bond underwriter and the investing public to withhold the desired financing assistance. However, in many such localities, expert analysis reveals economic potentialities that are sufficient to justify a loan to the district for the development thereof. Such possibilities would include a change in the use made of the land; for example, the raising of alfalfa and feed in conjunction with maintaining a dairy herd might give a return per acre, as compared with a crop of deciduous fruits, which might be ample to justify the financing for the development of the necessary increase in available water.

Vista District Cited

In California, the growing demand for country homes of small acreage, by owners not entirely dependent upon crop returns, brings a potentiality into the analysis of a district, which has materially influenced the attitude of investment bankers and investors in absorbing the securities of such districts. An example of this development is now going on in the Vista Irrigation District between Los Angeles and San Diego.

The foregoing are given to suggest the wide field for favorable analysis of an irrigation district even though the actual conditions and economic results attained may not be particularly convincing.

(3) *Economic Results Anticipated After Financing:* The analysis which falls under this heading, of course, is the primary basis for considering the loan. Obviously, in California, the data to be reviewed in the most exacting manner are those relating to the sufficiency of water, and the cost of applying same to the land. If it is a new district involving colonization and planting, it is extremely important to be satisfied as to the ready salability of the land and its actual settlement with farmers ready to accomplish its fullest development. In this regard, the productiveness of the soil and the crops proposed to be raised are of fundamental importance as, unless each acre of land becomes self supporting and produces a reasonable profit to the farmer, over and above his cost of operation, taxes, etc., the district as a whole is bound to suffer financial difficulties sooner or later. The experiences of some of the recently formed districts following the drought, hoof and mouth disease, drop in land values, etc., are examples as to how a district which was well conceived on paper can get into miserable financial trouble as a result of depending too much upon the sale of land

* Paper read before the Second Land Economics Conference sponsored by the Los Angeles Chamber of Commerce, at the morning session held on April 26, 1927.

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and the resulting colonization thereof, combined with insufficient proven diversification as to the uses which can be made of the land, from which the farmer can realize an immediate cash return.

Factors Studied by Bankers

This analysis also includes many of the economic factors above referred to, but, from the standpoint of *estimate* and *deduction,* as compared to the actual results revealed by the previous history of the district. Some of the many things which the investment banker scrutinizes most carefully in considering the economic features of an irrigation district bond are:

Transportation, both rail and highway.

Climate, its effect from the standpoint of both crops and human living conditions.

Domestic water supply—drainage and the effect of increased irrigation upon the soil with the attendant possibilities of artificial drainage by pumping.

Sufficiency of water to meet the water duty required for diversified crops.

Relation of marketing costs to the estimated production per acre.

Financial and moral responsibility of present and *prospective land owners.*

Demand and *prices for the land and the various crops* which have been determined by experts to be the most feasible to raise on the land within the district, etc.

(4) *Financial Condition of the District After Incurring of the Bonded Indebtedness:* This analysis includes carefully prepared resume of the district's proposed assessed and actual valuation—its direct obligation bonded indebtedness and other forms of indebtedness in ratio to such assessed valuation—its pro-rata share of the indebtedness and general tax levy of other political subdivisions of which the district in question is a part—the current obligations to be incurred by the district for operation and maintenance of the irrigation system; all of which is finally reduced to a net ratio of indebtedness per acre, and annual cost per acre for the duty of water properly required in that locality, and the total tax obligation per acre, including principal and interest requirements on the proposed bond issue. The ratio of total annual charges per acre to a conservatively estimated net income per acre is the final test as to estimated ability of the district to promptly meet principal and interest on its bonds.

As an offset to the various forms of liability above discussed there is also analyzed the revenues which may be received by the district annually from the sale of surplus water, and if the district has undertaken a hydro-electric development, conservative net profits after liberal estimates of operating expense, depreciation, fixed charges and necessary reserves, would make an offset to the current costs per acre which would very materially strengthen the credit standing of the district and therefore make the price and interest rate of its proposed bond issue more favorable to it.

Obviously the financial condition of the district will so directly reflect its business management that the personnel of the board of directors, officers and the individual charged with the management of the project are checked most carefully.

Marketability of Bonds

Enough for the strict economic and technical analysis establishing the intrinsic security and investment value of the bond. We now analyze the bond from the second viewpoint, previously referred to: *its marketability.*

Let us assume the proposed bond issue has become recognized in the opinion of the investment banker as a sound security which he can consistently offer his clientele and that all of the conditions which may be referred to by the other speakers here this morning as well as those outlined in this paper, as necessary requirements for the creation and financing of irrigation districts have been satisfactorily met. As is usually the case, the district calls upon the investment bankers for bids, and the interest rate is limited only as provided in the statute, namely, that, it shall not exceed 6 per cent. The buying department of the investment banking institution is satisfied with the security and now refers to the sales department for its opinion as to the present marketability of the issue.

There are several respects in which irrigation district bonds differ from ordinary municipal or political subdivision bonds in establishing their marketability. In the first place, irrigation district bonds are not generally salable outside of the state in which the district is located unless it appears to be an unusually large project and has collateral revenue such as that derived from hydro-electric development. The Merced Irrigation District of Merced County, California, and the Salt River Valley Water Users Association of Arizona are samples of the type of districts that have been able to establish their bonds outside of local markets. In the second place, it should be remembered that a very large percentage of our citizens have come from states which do not require irrigation for land development, and accordingly they often fail to appreciate that the securities issued for such purposes can be made fundamentally sound investments. In addition to this attitude there are many people who are prejudiced against irrigation district investments, either for no particular reason or because they may be familiar with the failures of some of the irrigation districts which have gone hand in hand with the development of the west. Consequently, to determine the marketability of such a bond it is necessary to analyze and consult the investor's viewpoint probably more than is true with any other class of security. It has been said that it is always a "buyer's market" when it comes to selling irrigation securities.

Factors Affecting Marketability

Furthermore there are often prejudices even among investors who frequently buy irrigation district bonds, which prejudices relate to certain districts, or arise out of the limited diversification of the crops which may be raised in said district or the uncertainty or lack of sufficiency in the water supply, or the general class and number of people owning the land of the district, or a prejudice which represents an uncertainty as to man's ability to reclaim certain classes of land, such as that of the Mohave Desert, against the destructive forces of nature.

Now the method usually followed in ascertaining the viewpoint of the limited number of buyers of this class of obligation is to analyze recent trading transactions in bonds of a similar class as far as intrinsic security goes, but which have been on the market for some time. The price at which such bonds have been bought in relation to the interest rate which they bear computes what we call in the bond business, the investment basis. For example—a 15-year 5½% bond bought at 95.10 nets the investor an average yield for the 15-year period of 6 per cent.

Approval of the proposed bond issue by the State Irrigation District Bond Certification Commission as legal investment for savings bank and trust funds would obviously broaden the market for the issue and establish a certain degree of recognition and confidence with the investing public.

As previously referred to, the demand for land and water within the district for purposes other than straight agriculture, such as residential or industrial development, further creates a favorable attitude on the part of the bond buyer and therefore upon the investment banker in purchasing the issue.

Other Factors in Fixing Price

Granting that all of the foregoing considerations have resulted in a favorable reaction on the part of the investment banker and he is satisfied that the bond both is an intrinsically sound investment and will enjoy a favorable reception on the market, the only remaining consideration in establishing the price and interest rate is to estimate the amount of the sales expense, carrying costs while the bond is being distributed, and the profit which he should realize for underwriting such financing. If, in his opinion, the current market basis for

(Continued on Page 21)

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A New Process For Lining Concrete Pipe Making It Impervious to Organic Matter

An Asphalt Surface Covers the Inside of the Pipe Enabling It to Withstand Acids Found in Sewage Matter

EVER since concrete pipe has been commonly used by engineers and constructors throughout the country, there has been a crying demand for a product which would withstand the ravages of organic acids. Concrete pipe can be made throughout the United States at a fairly uniform cost because the price of the materials from which it is made and the labor entailed in its manufacture are about the same everywhere.

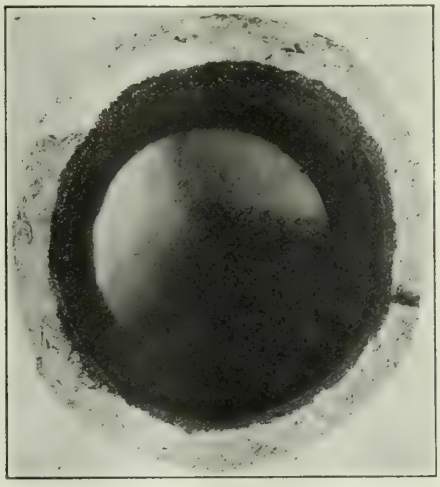
For many years, in fact ever since concrete pipe has come into common use, there has been a demand for it for sewage disposal. Coatings of many kinds, both inside and outside the pipe, have been tried without a great deal of success. It has been recognized that if the pipe were given a coat of pure asphalt, which is impervious to acids, that pipe would be far superior. Many times attempts have been made to give this asphalt coating, but without avail. It was found that when the cured pipe was coated with hot asphalt, there was not a sufficient bond between the two materials—the asphalt and the concrete—so that within a very short time the asphalt became loose and sloughed off in the form of chunks or strips. Protective paints were of little value because they did not contain enough of the asphaltic material.

Martin Invents Process

It has been found through experience, that concrete pipe will withstand the pressures for which it is designed and built.

As previously stated, many attempts have been made in the past to waterproof pipe successfully but all have been more or less failures. During the past two or three months, however, there has been devised a method which promises to revolutionize the concrete pipe business. This new process has been invented by a man who has devoted a great many years to the work, and who is well known to all pipe manufacturers, especially along the Pacific Coast. This man is George C. Martin, president of the Martin Iron Works, Los Angeles, who has for some years manufactured a machine for the making of concrete pipe.

This machine is unique from several standpoints and has met with a very favorable reception from the makers of concrete pipe. The concrete is properly mixed and fed into the hopper of the pipe machine, from which it is automatically delivered into the pipe mold. The inside of the pipe is formed by a revolving trowel, at the base of which is a smoothing head.



This photo shows very clearly how the amalgamation of the asphalt and the cement takes place. The hot asphalt is actually forced into the plastic cement, making a strong uniform bondage.

The trowels pack the mixture densely against the sides of the mold which forms the outside of the pipe, and as the extreme diameter of the trowels is arranged for the size of pipe being manufactured, the function that they perform is both primary and secondary. Just below the trowels and attached to the same shaft is the smoothing head, which is of the same diameter as the trowels. The purpose of the smoothing head is to stiffen the material as it is being kneaded by the trowels, and to prevent the excess material from dropping below the finished surface. The secondary action of the packer head is to smooth the molded surface upon which the trowels have acted and to impart a glazed finish.

Details of Manufacture

In beginning the manufacture of a joint of pipe, the mold is placed upon the working table of the machine with the center of the mold directly below the center of the shaft which rotates the trowels and the smoothing head. The smoothing head and trowels are dropped down into the mold so that the trowels are acting exactly at the base of the pipe section, the smoothing head passing through a hole in the working table and closing off exactly where the trowels start. The prepared concrete is then delivered into the mold from above and falls directly upon the trowels.

As the trowels revolve they are arranged to force the prepared material outward and downward against the sides of the mold. As the material is augered downward and outward it is very densely compacted into the space provided, which is the thickness of the wall of the finished pipe. A vertical lift is provided which, as the material is being compacted, lifts both the trowels and the smoothing head simultaneously, and the result is a finished tube of the compacted material which is held in place and together by the mold. For ordinary concrete pipe this finishes the operation except for the re-

(Cont. on Page 21)

A broken section of the new type pipe, made according to the method outlined. It can be seen how uniform the asphaltic coating is, and how it adheres to the cement surface of the pipe.

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The EDITORIAL

MODERN Irrigation

Reg. U. S. Pat. Off.

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RUSSELL R. PALMER
Editor

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District Financing

TWO problems are in the foreground whenever a new irrigation project is broached. The first is the question of where and how water is to be obtained—for if there is not a sufficient supply available, the project automatically falls through. If sufficient water is available there comes the question of how adequate financial arrangements can be made. This latter problem has two phases—financing on the part of the project or district as a whole, and financing on the part of the individual settler in the district.

MODERN IRRIGATION feels that it is fortunate in being able to present to its readers as authoritative a discussion of district financing as that by C. J. Thorson in this issue. As Mr. Thorson points out, the value of the bonds of any irrigation district depends upon a number of factors. Not only must the existing conditions be taken into consideration, but it is also necessary to analyze the potential possibilities of the project, and the economic results that may be expected after financing. It is necessary to consider the size of the proposed district—the larger projects become the greater the economic problems they involve. It will take longer to settle the land, and with increased costs of irrigation work and land development, more capital and skill will be required for success. An important factor is the location of the district—its transportation facilities and its nearness to a market for its products. If it is a new district that is yet to be colonized and planted, one of the most necessary factors to be investigated is the ready salability of the land and its settlement by farmers.

The problem is one then of constructing only projects which are feasible, and of developing a plan of land settlement whereby prompt utilization of irrigation construction will take place. The feasibility of the project can be determined only by careful engineering and economic analysis. Costs incurred in the purchase of raw lands and in the construction of irrigation works are no more important than costs incident to holding undeveloped land after construction and to the improvement and equipment of farms. Feasibility surveys will also include soil analysis and determination of the ability of the lands to give sufficient returns to meet the estimated costs.

When the early settlers in a project fail to develop farm land at a profit, there is little encouragement for new settlers to buy in that district. The failure of the individual settler is due in many cases to the fact that he has not realized the existence of many items of cost such as taxes that must be paid before development is completed, bonded debts not properly allowed for, and further construction that will be necessary before the irrigation work is complete.

The items of cost that make up the irrigated farm, as summarized by Professors Weeks and West in a paper presented before the recent meeting of the Land Economics Conference at Los Angeles, are (1) the raw land price, (2) the cost of the irrigation works, (3) the taxes paid before the land can use the water, and (4) the cost of improving and equipping the farm. But in many cases the farmer takes into account only the first two of these. The very considerable amount that will be paid out in taxes and interest is disregarded, and the sum necessary for improvement of the land and for the purchase of livestock and equipment is often greatly underestimated. Yet unless each acre of land becomes self-supporting and produces a reasonable profit to the farmer, over and above all costs of operation, including taxes, the district as a whole is bound to suffer financial difficulties sooner or later.

Safer Swimming Pools

THE marked interest manifested by readers of this journal in the report of the American Public Health Association and the Conference of State Sanitary Engineers on standards of swimming pool design, construction and operation, the concluding installment of which appears in the waterworks section of this issue, clearly indicates that the proposed standardized procedure in swimming pool construction has strong support in the engineering fraternity. The

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POINT *Of* VIEW

old order, in which practice as to construction, equipment and operation of swimming pools varied widely in different states and even in different communities within the state, seems definitely a thing of the past.

With the advance in recent years of standards of public health has come recognition of the fact that various transmissible diseases have been spread by the waters of poorly constructed and equipped or improperly operated swimming pools, by bathing in polluted waters and by the use of incompletely sterilized bathing suits and towels. The pressing need has been for a concerted effort on the part of some national agency in the formulation of standards for the physical, chemical and bacterial quality of swimming pool waters, together with a set of operating regulations for the maintenance of those standards.

And now this need has been met. During the past six years separate committees on bathing places of the Public Health Engineering Section of the American Public Health Association and the Conference of State Sanitary Engineers have worked practically as a single body making separate though similar reports each year to both organizations. Since 1925 these two committees have functioned as a joint committee and it is through their combined efforts that the present set of working principles has been evolved as a guide to the nation's waterworks engineers.

The code as it has been published in this journal is practically complete and, with possible minor changes, is in the form that will be adopted as final at the next meeting of the Public Health Engineering Section of the A. P. H. A. Immeasurable benefit to public health will result from the universal adoption of these standards by waterworks engineers.

A Model Bond Law

THE May, 1927, issue of the Journal of the American Water Works Association contains interesting editorial comment on the proposed model bond law for municipalities and other political subdivisions of the state, which has been submitted by the National Municipal League of New York City through its Committee on Municipal Borrowings.

There are, as the Journal points out, as many varieties of legislative practice in regard to municipal financing as there are municipalities. The procedure in the incurrence and subsequent payment of debts for municipal projects is, it asserts, subject to the vagaries of lay and professional individuals, in many instances unfamiliar either with the theory or practice of municipal finance.

The text of this model act, the Journal goes on to explain, represents the consensus of opinion of a group of experts, as to the purposes for which political entities may be authorized to borrow money; as to the terms and type of bonds to be issued for such purposes; and as to the provisions which should be made for sale and retirement. Such a statewide bond law is proposed in order to bring all localities to somewhere nearly a uniform standard practice.

Commenting further on the proposed legislation the Journal says:

"Although the proposed act contains no particularly novel features, it offers a guide to public officials who may be interested in accepting the lessons of experience and in eliminating the existing statutes which place municipalities at a disadvantage in the bond market. This suggestion of the committee for uniform and simplified practice is well worth the attention of the reader.

"Although there are some items in the proposed act upon which the experts could not agree, there are sufficient suggestive features therein to be helpful to any who are concerned with the incurrence of municipal indebtedness. The disagreement of the committee is particularly emphasized in the minority report on the issuance of sinking fund bonds. The majority of the committee goes strongly on record for the issuance of only serial bonds, whereas a minority of the committee believes that 'large cities with sound financial traditions should still be empowered to issue sinking fund bonds.' There is considerable strength in the statement of the majority that sinking fund bonds have frequently been misused by administrators. There is room, however, for discussion as to whether such bonds should be prohibited by state law in the case of such municipalities which have ample protection against defective and dishonest public administration.

"Among other things the model law permits the issuance of bonds only for permanent improvements. Bonds to meet current expenses are forbidden. Included in the act are schedules for the probable life of the property or improvement to be carried out. These schedules are intended to regulate the terms of the bonds.

"Another provision, the lack of which has hampered many public expenditures, is that permitting municipalities to sell bonds at less than par, but not less than 95 per cent of par."

Engineers in the western states who have had first-hand experience with the weaknesses of present legislation, with reference to municipal improvement financing will see in this proposed law, a step in the direction of standardized legislative practice that cannot help but overcome, in some degree, the inconsistencies and inadequacies that characterize many municipal improvement enabling acts of today.

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Development and Picking Scene in Fruit Ridge Section, El Dorado Irrigation District.

Vote Bond Issue for $1,300,000 Development in El Dorado District

Construction Work to Start As Soon as Securities Are Disposed of; District Takes Over Water Corporation

EL DORADO Irrigation District, El Dorado County, California, came into existence in September, 1925, when, by a vote of 6-1, the electors residing within the district decided that it should be organized. From that date on El Dorado Irrigation District was a legally existing irrigation district under the laws of the State of California. It was from that date an agency of the state with power to incur indebtedness, employ officers and levy assessments. At that election the electors chose officers and directors and by their vote in the formation of the district placed these men in office, gave them the power to proceed with plans for the development of a water supply, and by their vote authorized them to do this work and have these investigations at the expense of the district.

The preliminary investigations were carried on for considerable time, and many engineers were invited to submit plans for the district, and from these investigations, the plans and report of S. J. Norris of Oroville, California, were adopted by the board of directors. This report was approved by the Division of Engineering and Irrigation and the California Bond Certification Commission, and after a thorough investigation on their part, the commission authorized the district to hold a bond election. This election was held February 16, 1927, and the bond issue carried by better than two to one. These bonds are now being sold, and as soon as the proceeds are available, construction work upon the district will be started.

Norris Chief Engineer

S. J. Norris was appointed chief engineer and is now preparing plans and specifications for the proposed works covered in the initial development as outlined in his report.

The district has an option on and proposes to take over a going water utility which is now irrigating 4000 acres of producing orchards and 2000 acres coming into bearing. The gross returns from the crops for 1926 on the 4000 acres of bearing orchard is said to have been approximately $2,000,000.00 or an average of $500 per acre.

There are 30,702 acres within the district boundaries of which about 20,000 acres are susceptible of irrigation and 6000 acres are now planted and irrigated.

The City of Placerville is also within the district boundaries and depends upon the district for its water supply. Placerville is the county seat of El Dorado County and is the terminal of the Southern Pacific Railroad Company. Placerville has about 2,500 population and is located practically in the center of the district. A high school and two grammar schools are maintained within the city. Two banks are supported with deposits of about $2,000,000.00 Headquarters of El Dorado National Forest is located in Placerville. Here are four churches and representative fraternal organizations.

Regarding the District

Gross Acres	*30,000*
Net Irrigable area (acres)	*20,000*
Net Improved now Irrigated (acres)	*6,000*
Average size of holdings (acres)	*70*
Population of District	*4,000*
Holdings in District excluding Placerville	*450*
Holdings in Placerville	*500*
Value of all property in District	*$8,000,000*
Lands	*3,000,000*
Improvements—buildings	*2,500,000*
Improvements — Orchards and Personal	*2,500,000*
Assessed value of lands	*2,200,000*

Proposed Development

The following is a brief summary of the work as proposed and which will be covered by the initial bond issue of $1,300,000.00

1. Storage and right of way for Hazel Valley Reservoir, $436,817.00.
2. Main conduit from Sly Park Creek to North Webber Creek, $245,158.00.
3. Webber Ditch reconstruction cement gunite lining, $60,873.00.
4. Placerville City Waterworks connection with Webber Ditch, $32,400.00.
5. Distribution laterals, enlargement extension and replacement of structure, $51,840.00.
6. Purchase lot and construct office building, $12,960.00.
7. Partial Bond interest for three years, $109,952.00.
8. Purchase the El Dorado Ditch System, $350,000.00.

Total, $1,300,000.00.

The plan of the El Dorado Irrigation District contemplates the building of a reservoir at the Hazel Valley site. For this purpose, as can be seen from the above figures, there has been allotted $436,817.00 from the total bond issue. The Hazel Valley site is located on Park Creek, a tributary of the Consumnes River, and is reputed as being one of the outstanding reservoir sites of the country. At this location, a dam can be economically built which will have a capacity in excess of 60,000 acre feet. There are fifty-four square miles of watershed feeding this reservoir site, and permits have been issued by the Division of Water Rights covering the necessary requirements of the district. Options have been obtained upon this site, and are well under the estimated cost.

Rainfall Figures

Hydrographic and precipation studies of the area feeding the reservoir site, show that the mean seasonal rainfall for over a period of forty-eight years, has been in excess of forty-three inches. Placerville is approximately in the center of this area.

Construction of the Hazel Valley dam will not be a difficult or costly matter, it is understood. Suitable material for this work is available at the site, and as the land upon which the location has been made is nearly devoid of timber,

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but little clearing will be necessary.

The El Dorado Irrigation District will also take over the El Dorado Water Corporation which has the perpetual right to 40 second feet flow from the American River and whose physical properties have a replacement value of over $600,000.

This system extends throughout the district and is the nucleus of the formation of the irrigation district.

There are over 70 miles of canals in operation and very little extensions are necessary to entirely serve the district.

Erect Packing House

The El Dorado Irrigation District comprises some fine farm lands. Deciduous fruits comprise the most important produce shipped from this locality, and in order to accommodate this growing industry, the Fruit Grower's Association has erected a large packing house at Placerville. This plant is 586 feet long and two stories high with a shipping capacity of 25 cars per day.

It is equipped with the most modern box making machines and eleven automatic graders and employs 90 packers and over 100 other people during the packing season. The pears are brought to the packing house in the morning and shipped out the same day.

Standardization of pack and quality of the product and the fact that the fruit is harvested late in the season make market conditions ideal. There is practically no competition in the Eastern markets when the peak pack is being marketed.

There has been created a demand in the Eastern markets for the El Dorado County Bartlett Pear, which is shipped under two brands, namely: *"The Placerville Maid"* and *"Placerville Tahoe Brand."*

The pooling by the growers of the day's harvest and shipping under two brands has brought wonderful results as regards the demand for and the price obtained for the fruit.

Planting Figures

The district is rapidly growing, as is evidenced by the following planting figures. Bartlett pears, which do particularly well in this locality, constitute the major acreage, but there is a sizable sprinkling of other fruits which will tend to stabilize the district's economics as a whole.

The following is tabulation of acreage planted in 1926, with approximate percentage.

Pears	2,650 Acres	45%
Grapes	880 Acres	15%
Prunes and Plums	885 Acres	15%
Peaches	650 Acres	11%
Apples	400 Acres	7%
Cherries	120 Acres	2%
Almonds	60 Acres	1%
Walnuts	60 Acres	1%
Apricots	25 Acres	1%
Figs	20 Acres	1%
Berries	100 Acres	1%
Miscellaneous	50 Acres	.....
	5,800 Acres	100%

About 150 acres of alfalfa and clover are grown in the district. A large acreage of potatoes is grown and chickens and dairying also fill in toward carrying the new acreage into bearing.

New Lining for Concrete Pipe

(*Continued from Page 17*)

moval of the mold. The finished pipe and mold are taken to the curing floor where the mold is removed and the pipe allowed to cure properly for the desired period of time before being put on the market.

New Process Described

The second operation, which is the new process, takes the pipe still in the mold, to another machine identical in design and operation with the machine which forms the pipe originally. In this second operation the inside surface of the still plastic but finished concrete pipe is used as the restraining surface and into this the second material is troweled. This second material is pure asphalt mixed under a definite temperature with a proper proportion of very fine sand. The mixture of the asphalt and sand is necessarily hot, approximately 300 degrees Fahrenheit. It is only at such a high temperature that this material can be properly troweled and molded, as it sets at lower temperatures and becomes impossible to work.

The operation of the second machine is identical in operation with that of the first. The material is troweled and formed against the restraining surface of the already molded pipe but, because the first material is yet plastic, the second material is forced into it, making a definite bond upon the first surface. The impregnation of the asphalt is so thorough that where the joining takes place the asphalt and the cement become integral, and amalgamate definitely and decisively. The actual physical reaction between the two materials is not exactly known, but results show that there is a bondage which tests have proved to be lasting. The accompanying photographs have been taken of broken sections of the bonded materials and it can be seen that while there are two different materials, the line of demarcation between the two is very indefinite.

The demand for a product such as has been described is wide and promises to enlarge greatly the scope of operations of concrete pipe manufacturers. The asphaltic coating, which can be of any desired thickness, is to a great extent impervious to certain organic and inorganic acids which attack concrete. The asphalt, as applied in this new method, is no longer in the category of a coating, but assumes the position of a molded portion of the pipe which, when properly cured and set with the original pipe, assumes similar characteristics. It is impervious to moisture and of course lasting. When used as sewer pipe, the joints are made with hot asphalt which adheres to the asphaltic interior surface of the pipe, making a continuous lining entirely of asphaltic material so that the deteriorating elements have no chance to touch, much less act upon the concrete itself. After filling the points with hot asphalt, the outside is joined with cement, making strong acid-proof bondage which heretofore has been impossible.

E. F. Bent First User

This new method of pipe manufacture is receiving widespread attention. It is applicable to all kinds of concrete pipe, not being limited to any certain type or brand. Of course, the inventor of the process is licensing the manufacturer of asphaltic lined pipe, but modern commercial methods will make it available to all who desire to use it. One of the first men prominently identified with concrete pipe manufacture, and one who is considered as a leader of the conservative element, and who has definitely accepted the new process, is Ernest F. Bent, of the Bent Concrete Pipe Company. Mr. Bent has purchased the exclusive rights for the ten Southern California counties.

The inventor states that the new process is yet in its infancy, but that he is constantly conducting experiments in an endeavor to improve the present method, and that in time he will be able to deliver a product which will satisfy even the most rigid duties which have been heretofore only the field for a lead pipe or its equivalent.

Problems of Irrigation Finance

(*Continued from Page 16*)

the bond is 5¾ per cent, obviously he must decide whether it is advisable to buy a 6 per cent bond and offer it to the public at a premium, or whether he should buy a 5¾ or 5½ per cent bond at a discount and offer to the public at par in the case of a 5¾ per cent coupon rate bond, and at a discount in the case of a 5½ per cent bond, so as to yield the market basis of 5¾ per cent. Ordinarily if the district is one which is apt to develop rapidly after the proposed improvements are installed and thereby gain recognition on the market shortly after offering the bonds, he will probably prefer to bid for a 5½ per cent bond and retail it at a discount, expecting that in the course of a comparatively short time the bonds will be actively traded in at par or better when the credit position of the district improves as a result of the proposed improvement.

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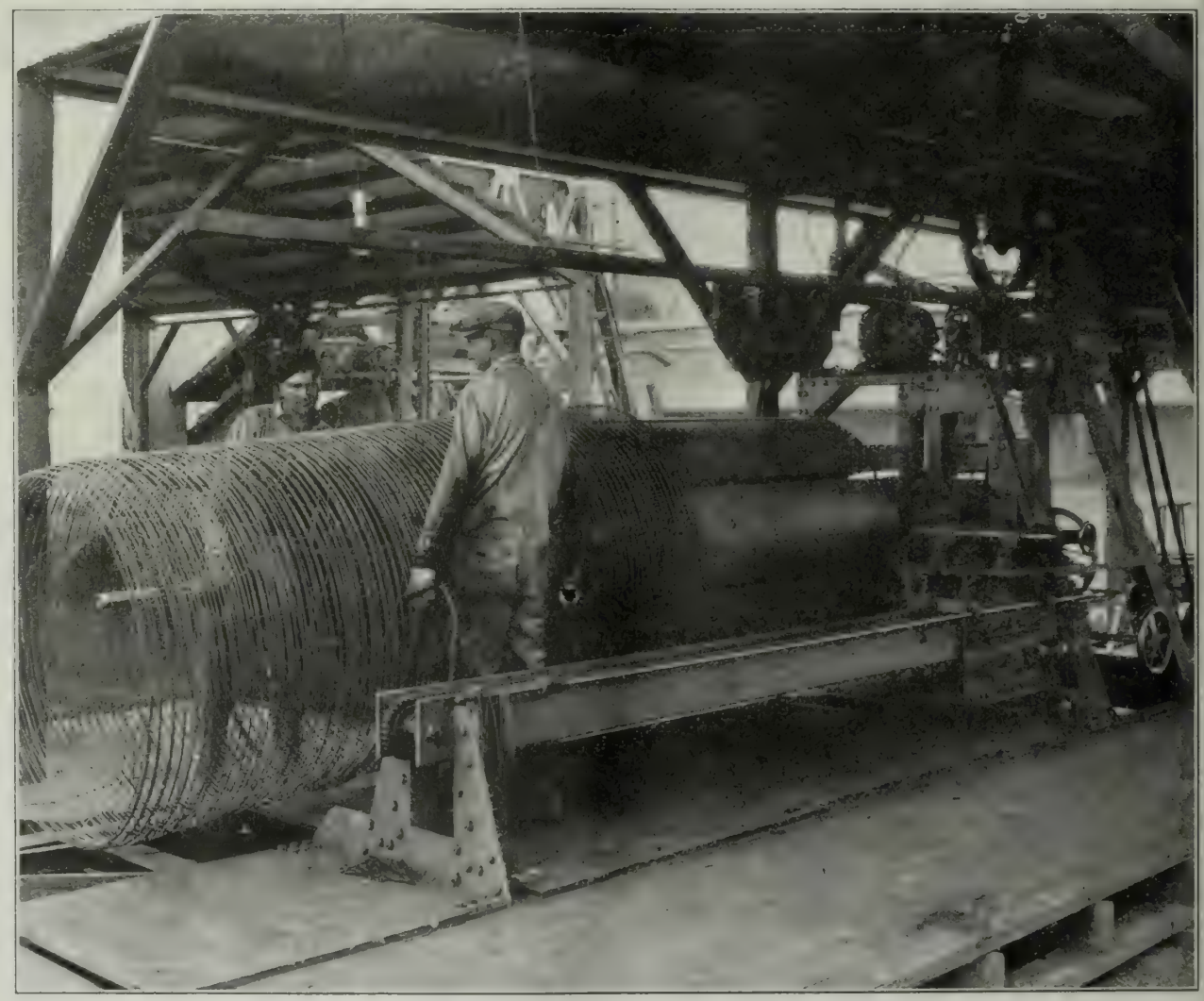
Hume Centrifugal

The Modern Pipe



Fabricating reinforcement for 42-inch Centrifugal Pipe

40,000 feet of 42-inch Centrifugal Concrete Pipe for City of Riversid

REABURN AND BOWEN, Central Building

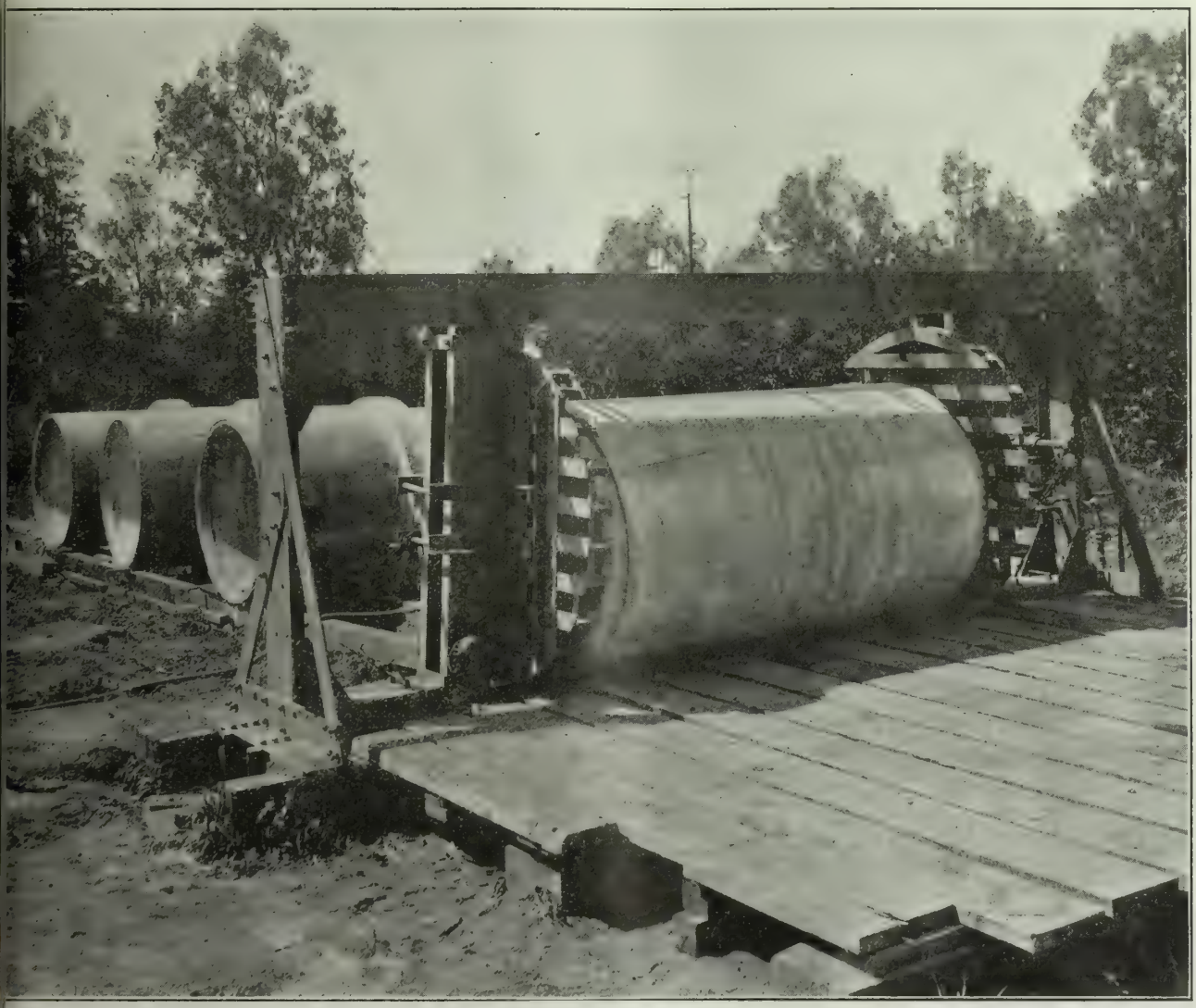
WESTERN CONCRE

LOS ANGELES P. O. BO

"Western Waterworks" Begins on Page 25

Concrete Pipe

For Pressure Lines



Testing Pipe for Internal Pressure. Pipe showed no percolation at 85 pounds pressure.

Water Supply Line to operate at 60 pounds pressure per square inch.

Los Angeles, California, Engineers

E PIPE COMPANY

5 CALIFORNIA

"Western Waterworks" Begins on Page 25

SURFACE IRRIGATION PIPE

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Breed Joins Modern Irrigation's Board of Advisors

One of the recent additions to the Board of Advisors of MODERN IRRIGATION is E. M. Breed, sales manager of the Pelton Water Wheel Company of San Francisco. Mr. Breed is a well known engineer of the hydraulic fraternity, and is considered an authority in his profession.

The new member of the board is a graduate of the University of Maine,

E. M. BREED

obtaining his electrical engineering degree from that institution in 1904. His first practical experience was secured in the training school of the Westinghouse Electric & Manufacturing Company at East Pittsburgh. Mr. Breed's work in the school was so well thought of that he was placed in the foreign service department and sent to the Montreal office of the Canadian Westinghouse Company in the capacity of sales manager.

The Canadian Allis-Chalmers, Limited, which conducts extensive operations in western Canada, later became interested in Mr. Breed's work with the Westinghouse Company and sent for him. He was appointed western district manager, and served in this capacity for eight years. He resigned this position to become associated with the Pelton Water Wheel Company, which concern he now represents.

Mr. Breed is a member of the American Society of Mechanical Engineers, and is first vice-president of the Engineers' Club of San Francisco. He is also a member of Phi Kappa Phi, electrical engineering honor society.

Centrifugal Concrete Pipe

(Continued from Page 13)

joints are made so that they are self centering. On the outside of the pipe, and flush against the collar, a length of twisted tar paper is wrapped around the entire circumference, so that it acts as a dam to the grout when it is poured between the collar and the pipe.

As rapidly as the pipe is placed in the ditch and set, a group of backfillers cover over the pipe, so that it rapidly obtains ground temperature, and also prevents evaporation. While the backfilling is taking place, men point up the inside joint to within ¾ or 1 inch of the finished surface. Within four or five hours, the men pouring the joints from the outside come along and finish the first portion of the work on the joint. In all of this work, a one to one mixture is used, only clean sharp sand being used throughout. In making turns, either a bevel cast pipe is used, or ordinary cast pipe with 1/10-inch bevel which accommodates a 100-foot radius turn. In these cases a 12-inch collar is used instead of the usual 8-inch, and this is properly tamped, and pointed inside and out.

After the joints are poured and all parts of the material have reached the same temperature, the inside of the groove is filled, and properly smoothed over. In case there is a slight difference in the diameters of the two joining sections, a perfectly smooth joint is made, building up the low portions to join with the higher sections. This allows the water to have a perfect streamline flow, without turbulence, over the joint.

All outlets are made in a rather unique manner. The pipe is cleaned off, and the desired diameter opening cut. The entire surface is then covered with plastic cement, which has been mixed with a small amount of lime water to retard setting, and a steel shield covering the upper portion of the pipe is laid on this plastic surface. This shield carries the steel outlet of the desired size, which is electrically welded thereto. This outlet pipe sets down into the concrete pipe so that it comes nearly flush with the interior surface. Several steel straps fit under the lower section of the pipe, and draw the upper shield tight against the pipe, excluding the surplus cement out around the edges of the shield. The cement is then allowed to set, and after setting, the entire exterior shield is covered with concrete, protecting the steel from corrosion.

San Gabriel Dam Plans O. K'd.

The Board of Supervisors of Los Angeles County have adopted the plans recently submitted for the San Gabriel Dam, the county flood control project. Bids will be opened July 11, 1927.

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WESTERN Waterworks
Supplement to Modern Irrigation
Of Interest Expressly to Waterworks Executives, Contractors, and Municipal Engineers

"Let's Go Chicago," Convention War Cry of A. W. W. A.; California to Be Represented

THE American Water Works Association will hold its forty-seventh annual convention in Chicago, Illinois, June 6 to 11. Among the papers to be presented during the convention are the following: "Quality of Water and Industrial Development," by W. D. Collins; "The Underwriters Laboratory and Water Works Equipment," by Dana Pierce; "Restoration of Service in Miami Following the Hurricane," by H. H. Hyman; "Chlorination Control in Chicago," by A. E. Gorman; "Distribution System of the Chicago Water Works," by J. B. Eddy; "Legal Decisions Affecting the Financing of Water Utilities," by Cecil F. Elmes; "Duplex Filter Bottoms," by F. B. Leopold; "Symposium on Well Water Recessions"; "Recent Developments in Control of Electrolysis," by E. E. Minor; "Water Hammer, Its Cause and Control," by Loran D. Gayton; "The Story of Chlorine," by Robert T. Baldwin; "Sedimentation Studies of Turbid American Rivers," by A. W. Bull and G. M. Darby; and "Recent Developments in Water Pipe," by Ralph R. Silver. The Water Purification Division announces three sessions with programs covering the various problems in that field, and Committee No. 19, in two conferences, will give its reports on Boiler Feed Water Studies with the presentation of some seven papers on different phases of the subject.

A large delegation from the western states will attend the convention. Among those representing the California Section of the A. W. W. A. will be: S. B. Morris, chief engineer of the Pasadena Water Department, president; Paul E. Magerstadt, of the East Bay Water Company, Oakland, secretary-treasurer; George W. Pracy, superintendent of the Spring Valley Water Company, San Francisco; F. M. Randlett, of the Robt. W. Hunt Co.; Alexander Bell and G. T. Luippold, of the Wallace and Tiernan Co.; R. M. Sedgwick, district manager of the Pacific Gas and Electric Company, Dixon, California; and J. R. Barker, of the Neptune Meter Company.

S. B. MORRIS

President of the California Section of the American Waterworks Association, who will head the coast delegation to the 47th annual convention of the parent organization at Chicago, June 6 to 11.

Inspection Trips Planned

The Chicago Committee on Arrangements has planned many interesting program and entertainment features. Among the more important inspection trips for which arrangements have been made are: The new 300 m.g.d. Western Avenue pumping station, said to be the world's largest, which is equipped with modern steam turbine centrifugal pumps; the Chicago Avenue Tunnel, 16 feet in diameter, being dug through solid rock 200 feet beneath Lake Michigan; a 90-foot diameter crib for the tunnel intake being constructed at the municipal pier for launching this summer; new one-half m.g.d. experimental water filtration plant, where elaborate studies on Lake Michigan water will be conducted during the next two years; the laying of 48-inch and 36-inch cast iron pipe by special equipment and novel engineering methods; the 800 m.g.d. North Side activated sludge sewage disposal treatment plant of the sanitary district, said to be the largest in the world.

General entertainment will include a reception and ball, a boat ride on Lake Michigan, a dinner dance and smoker. For the ladies who attend the convention there will be in addition an informal reception and tea; a theater party; a conducted tour through the Marshall Field Co. store, followed by a luncheon and style show at the store; a tour through the park and boulevard system of Chicago, with a luncheon at the Edgewater Beach Hotel.

The Fleischacker Memorial Pool in Golden Gate Park, San Francisco, California, is probably the largest swimming pool in the world. It has a capacity of 5,200,000 gallons, and is operated according to the most advanced methods of swimming pool sanitation.

Swimming Pool Sanitation is Achieved Through Much Forethought and Care

Second Installment of Report on Standards for Their Design, Construction, Equipment and Operation*

Editor's Note: A code of standards for the design, construction and equipment of swimming pools has been drawn up by a joint committee from the Public Health Engineering Section of the American Public Health Association and from the Conference of State Sanitary Engineers. The first part of this report, covering the general recommendations of the committee, and the fundamental principles of design and construction, appeared in the March issue of WESTERN WATERWORKS. This was received with much interest, and at the request of a number of readers the remainder of the report is now given.

The term "bathing place" as used by the committee includes all bodies of water used collectively by numbers of persons for swimming or recreative bathing, together with the shores, buildings, equipment, and appurtenances pertaining to such bathing places. The committee believes that all public bathing places, both natural and artificial, should be under the sanitary control of the public health authorities, and that the same standards of cleanliness and bacterial purity of the water and the same precautions against the possible spread of disease should apply at both indoor and outdoor swimming pools.

The location and layout of the pool were discussed in the first article, as were the primary features of the design and construction. It is the committee's opinion that in the design of a new pool provision should always be made for complete circulation of water through all parts of the pool during the bathing period. Indoor pools should be of rectangular shape, with deep water at one end and shallow water at the other. The length of the pool should be not less than 60 feet, and the width should be some multiple of 5 feet. The lining, including bottom and sides up to the runways, should be of white or light color material and should present a smooth finished surface without cracks or joints.

The first installment of the report discussed the area that should be provided in proportion to the maximum number of bathers to be expected. It gave definite recommendations as to inlets and outlets to be provided, and the construction of scum gutters. The points to be heeded in regard to dressing rooms, showers, toilets, and visitors galleries were taken up, and the problems of lighting, ventilation and heating were considered. This second and concluding installment begins with a description of the recirculation system.

THE recirculation system consists of the pumps, hair catcher, and filters, together with all necessary pipe connections to the inlets and outlets of the pool. The water heater, the chlorinator and the suction cleaner are also usually installed on or connected with the recirculation system and may be considered as integral parts thereof. This entire system and all its component parts should be designed to provide the required volume of recirculation water as specified on page 00, with a minimum of frictional resistance. Filtration and disinfection are discussed separately in subsequent chapters. The requirements for other parts of this system are as follows:

B. *Pumps:* Centrifugal pumps are preferable for swimming pool circulation, although plunger pumps are sometimes used. Electric drive is also preferable. When pipe lines from suction cleaner lead to pump suction, a pump which will develop good vacuum must be used. When pressure filters are used pumps must be designed to pass the required volume under the maximum head which may develop in the filters. When designed to operate with multiple unit filters it is advisable to have pumps in duplicate with proper cross connections to permit one filter to be washed with the effluent from another. If filters are located at an elevation higher than the water line of the pool a check valve must be placed on the pump suction.

C. *Hair Catcher:* The recirculation system should include a strainer to prevent hair, lint, etc., from reaching the filters. The best type of hair catcher consists of a metal chamber containing a removable cylindrical strainer, so arranged that the water passes through the strainer from the outside. The strainer should be of non-corrosive material with openings not more than 1/32 inch across. A slotted strainer is more easily cleaned than one which is perforated. The area of strainer openings should be at least ten times the area of the water inlets. Hair traps should be so constructed that they can be quickly taken down for cleaning by loosening two or three wing-nuts. Proper valves should be provided to prevent flow of water through the strainer while cleaning.

D. *Water Heater:* In northern climates some method of heating the water is essential for indoor pools. Blowing steam directly into the pool as is practiced in some instances or heating coils placed directly in the pool are not recommended. A heater designed to heat all or a part of the circulation water is preferable. In designing a heater, ample surface for heat interchange must be provided. Such a heater may be designed for use with steam or hot water. Automatic thermal control is desirable. Provision should be made for easy removal of the heater parts for cleaning.

E. *Suction Cleaner:* In the opinion of the committee the only satisfactory method of removing the dirt, hair, etc., settling on the bottom of a pool is by means of a suction cleaner. As such cleaners are commonly operated by the circulation pumps, they may be classed as an adjunct to the recirculation system. When a suction cleaner is to be operated by the recirculation pump, a gate with graduated stem or other registering device should be provided for throttling the flow from the pool outlet to permit the pump to operate at maximum efficiency when the suction cleaner is in use. Fixed pipe connections for attachment of suction cleaner to pump suction should be of ample size to reduce friction to a minimum and the cleaner and all removable connections should be designed to provide a maximum velocity at the suction nozzle.

*Report of the Joint Committee on Bathing Places of the A.P.H.A. and the Conference of State Sanitary Engineers, presented to the Public Health Engineering Section of the A.P.H.A. at the fifty-fifth annual meeting, at Buffalo, N. Y., October 12, 1926.

F. *Piping System:* The piping system should be properly designed to reduce friction losses to a minimum. Pipe capacities should generally be at least double the theoretical value. Flange joints or unions should be inserted at intervals to permit any part of the system to be quickly taken down for cleaning or repairs. A sump and blow-off should be provided at the lowest part of the system to permit removal of any accumulating iron rust. Openings should be provided for insertion of gauges to permit vacuum on pump suction and pressure at discharge to be determined, should a study of the recirculation system be desirable. It is advisable also to make provision for insertion of Pitot tubes or meters for checking the actual volume of water passing through the system under working conditions. Outlets should be provided for obtaining samples of the water as it leaves the pool and after filtration for purposes of laboratory tests. Other requirements for piping are discussed under the heading "Inlets and Outlets."

G. *Testing the System:* After the recirculation system has been installed and the various units tuned up, a test of the hydraulic properties of the entire system and of each integral unit should be made. In such a test the velocity in the piping system at various points, the discharge capacity of each filter and each pump, the velocity and volume of wash water in each filter, and the rate of discharge at each pool inlet should be determined under actual working conditions with the pool at normal working level. The full data of this test should be a matter of permanent record for future comparison. A similar test repeated at least once a year is desirable.

Water Interchange for Recirculation

A. In a recirculation or flowing through pool in which the dirty or used water is continually being withdrawn and replaced by fresh or filtered water, purification of the pool water proceeds by consecutive dilution. The first portion withdrawn from the pool will all be dirty water but, owing to the constant admixture of entering clean water with the dirty water remaining in the pool, each succeeding portion of water withdrawn will consist of a decreasing proportion of dirty water mixed with an increasing proportion of clean water. In proportioning the rate at which fresh water should be added to a flowing through pool, or the capacity of pumps, filters, etc., for a recirculation pool, this law must be taken into consideration.

B. Gage and Bidwell have recently worked out the law of purification by consecutive dilution as applied to recirculation and flowing through pools. The following abstract of a paper in preparation has been arranged by the authors for this report:

It is proposed that the rate of water interchange in a recirculation or flowing through pool be expressed as the ratio of the volume of clean water entering the pool in 24 hours to the total pool volume. For convenience this ratio may be called the "Turnover" rate or "T" of the pool purification system. For example, T = 1 when the volume of water recirculated in 24 hours is the same as the pool volume, T = 2 when the water circulated in 24 hours is twice the pool volume, etc.

It can readily be demonstrated by computation and by experiment that 7 turnovers are required to effect a removal of 99.9 per cent of the dirt present in the water of the pool when recirculation was started. At the end of the first turnover the purification will be about 63 per cent, after two turnovers about 86 per cent, at the end of three turnovers about 95 per cent, after four turnovers about 98 per cent, after five turnovers 99.3 per cent, and after six turnovers 99.7 per cent. To accomplish a purification of 99.99 per cent 10 turnovers will be required.

If the pool is used regularly by bathers further increments of dirt will be introduced into the water daily, and the removal of each successive daily increment will proceed according to the law. The result of the addition of such daily increments will be an increasing accumulation of dirt in the water up to a certain point, after which the dirt content of the pool water will remain practically constant, subject only to the fluctuations caused by the variations in the daily bathing load. The amount of this accumulation and the time required for the pool water to reach a condition of equilibrium depend upon the rate of turnover of the pool by the flowing through or by the recirculation system, and in the latter system is also dependent upon the efficiency of the filters.

Assuming a daily increment of dirt equal to that in the pool at the start and a filter efficiency of 100 per cent, with a daily turnover (T = 1) equilibrium will be reached at the end of the ninth day when the accumulated dirt in the pool will be equivalent to about 58 per cent of the amount present when recirculation and daily bathing was started. With two turnovers per day (T = 2) equilibrium will be obtained in four days with a dirt load of about 16 per cent, with T = 3 a balanced load of about 5 per cent will be obtained on the third day and with T = 4 a balanced load of about 2 per cent will be obtained at the end of the second day. On the other hand, if the recirculation system is so small that it requires two days for each turnover, accumulation of dirt in the pool will continue for about nineteen days and the dirt load carried in the pool thereafter will be about 155 per cent of the amount present at the start.

It is evident, therefore, that if clean water is to be maintained, the recirculation or flowing through system must be designed to provide a turnover ratio of at least two and that where heavy bathing loads are anticipated, the turnover ratio should be three or more. It is also evident that the recirculation or flowing through system should be kept in operation continuously and that the filters should be operated in the most efficient manner. If the filters have an efficiency of only 50 per cent, or the recirculation system is operated only half the time, the effect will be the same as though the recirculation system were only half the size.

Filtration

A. Slow sand filters, rapid gravity filters and pressure filters have all been used in swimming pool repurification systems. More than 80 per cent of the recirculation pools in this country are equipped with pressure filters and for indoor pools and small pools where space is limited, this type of filter is to be preferred unless the water is very hard. For large outdoor pools the gravity type rapid filter is suitable and is preferred by some sanitary authorities. Where the water is very hard and cementation of the filter medium is likely to occur the open type of filter is to be preferred. Because of the large amount of space required, and the increased amount of hand labor required in cleaning, slow sand filters are seldom used for swimming pools.

B. Batteries of two or more filters arranged in parallel are preferable to a single unit, in order to permit continuation of filtration and recirculation while one unit is out of operation for cleaning or repairs.

One of the smaller, but popular plunges in the Southern part of California, is located at Alhambra. This is an outdoor pool, and is generally filled with bathers. Modern sanitation equipment is used in connection with the operation of this pool.

The Hearst Memorial Pool, on the campus of the University of California at Berkeley, has just been completed. This pool is a wonderful example of modern pool design, and will be operated according to the highest standards. This pool is for the exclusive use of the co-eds of the university.

C. Filtering material should consist of at least 36 inches in depth of suitable grades of screened sharp filter sand or crushed quartz and filter gravel. There should be at least 18 inches of freeboard above the surface of the filter material to the overflow troughs or pipes of rapid filters to permit proper washing without loss of filter sand. In some cases filters of bone charcoal, wood charcoal, or similar material have been installed on swimming pool recirculation systems. When new these materials may have considerable absorptive effect, but after a few weeks' use this power is lost and the filter becomes practically worthless until the filter medium is renewed.

D. In designing a filter system for a swimming pool the rate of slow sand filters should not exceed three million gallons per acre per day, and the rate of rapid filters should not exceed three gallons per minute per square foot of surface area. Automatic rate controllers are essential on slow sand filters. Rate controllers are not usually installed on the rapid filters used for small swimming pools because of the considerable increase in cost. Filters for large pools (100,000 gallons or more) should be equipped with rate controllers and such control is desirable on smaller installations.

E. Rapid filters of open gravity type must be equipped with loss of head gauges. Pressure filters must be equipped with pressure gauges on the inlet pipe and the outlet pipe for determination of loss of head or back pressure in the filter medium. Pressure filters should have a proper sight glass installed on the waste discharge pipe by which the operator may watch the progress of filter washing. Such glass should be readily removable for cleaning. When pressure filters are located at an elevation above the water line of the pool each filter must be equipped with an automatic air relief valve. The arrangement and number of valves and interconnecting piping, or "valve nest," for necessary and convenient operation of rapid filters is fairly well standardized, and a discussion thereof may be omitted.

F. Readily removable heads or a large manhole should be provided on pressure filters to facilitate inspection and repairs. Sufficient head room and working space must be allowed about filter units of all types to permit sand replacement and other repairs when necessary.

G. If the water supply contains iron, manganese, turbidity, or any appreciable amount of color, treatment with alum or other coagulant will be necessary with slow sand filters as well as with filters of the rapid flow type. On filters for pools of more than 50,000 gallons capacity, solution tanks and orifice boxes are to be preferred to the "Alum Pot," so-called, which is usually installed for use with small filters.

H. When the water supply for a pool contains large quantities of calcium bicarbonates, and especially when such water must be heated for use, difficulty is often experienced in maintaining clear water in the pool by the usual methods of coagulation and filtration. To a certain extent this difficulty may be overcome by passing the alum-treated water through a properly designed coagulation and sedimentation basin before filtration. Where the installation of a proper coagulation basin is impracticable it is suggested that water softening apparatus of the zeolite or base exchange type be installed as an adjunct to the recirculation system to permit the calcium content of the pool water to be reduced to a reasonable amount.

Disinfection

A. From all available information the addition of chlorine either as a gas or as a water solution by use of proper apparatus is today the most satisfactory method of pool disinfection. It is possible not only to completely disinfect the entire body of water in the pool with chlorine, but also maintain in the pool water at all times a residual amount of disinfectant to sterilize immediately any dangerous pollution disseminated by bathers. With the proper chlorine apparatus it is also possible to increase or diminish the dosage as required to compensate for variations in the bathing load. The committee recommends the use of chlorine either as a gas or as a water solution for disinfection of all pools where there is any appreciable bathing load or where bathing suits are worn.

B. A possible objection to the use of chlorine for indoor pools is the chance of accidental escape of gas into the room. Modern chlorine apparatus is carefully designed and built to prevent possibility of such accidents. As a factor of safety it is advisable to install the chlorinator and tanks in a special closet with vents near the floor connecting with a chimney or other duct leading outside the building.

C. Next to treatment with chlorine as gas or water solution, continuous application of a solution of hypochlorite of lime or hypochlorite of soda is the most effective method of swimming pool disinfection. It is sometimes difficult to handle and apply these chemicals without escape of some objectionable odor into the room. When open to the air these chemicals also change rapidly in chlorine content and frequent tests of the strength of solution being applied and readjustments of the rate of application, as well as frequent tests of the residual chlorine in the pool water, must be made when this method of disinfection is used.

D. Intermittent disinfection with hypochlorites as practiced at many pools must be considered a makeshift. It is possible to obtain satisfactory disinfection by intermittent application of these chemicals and to maintain a satisfactory residual chlorine content in the water when the bathing load is constant and not too high. When the bathing load fluctuates widely the residual chlorine content cannot be adjusted to compensate for these variations, and under excess loads immediate disinfection of infectious matters from bathers may not be accomplished.

(*Continued on Page 40*)

Recent Developments in Water Purification Show Increasing Demands for Better Water

As Standards Become Higher More Complicated Treatment May Be Expected and Future May Bring Radical Changes

By C. ARTHUR BROWN

Chief Engineer, Engineering Bureau, Water Purification, American Steel and Wire Company

Editor's Note: The Texas Waterworks School at its session last January asked C. Arthur Brown to discuss the subject of water purification, its recent developments and its present trend. Through the courtesy of the American Steel and Wire Company, WESTERN WATERWORKS was given the privilege of presenting this paper to its readers.

The first installment of the paper, published in the April issue, took up in detail the chemical treatment of water supplies. In Mr. Brown's opinion, the trend is unquestionably towards a more complex and increasingly difficult chemical treatment and with this the engineer faces more and more difficult problems in chemical control and application. The various treatments described, with their methods of application, were alum, sulphate of iron, lime, and soda ash. While the present trend in chemical treatment is undoubtedly towards even a greater use of dry feed machines, developments are under way which seek to utilize saturated solutions, and it would appear that this offers a relatively cheap and practical method of chemical application which may come into rather general use in water purification systems.

An almost indispensable part of the modern mechanical filter plant is the mixing chamber, in which the chemicals are quickly and thoroughly mixed with the water flow. The several different types of mixing chambers are described in the first installment. The second and concluding installment of Mr. Brown's paper begins with a discussion of settling basins.

THE FLOW, after passing the mixing chamber, is conducted into the settling basins. As we have seen, the function of the mixing chamber is partly to form the coagulation into large and well defined masses of coagulated matter so that it may be deposited from the water in which it is suspended.

If the flow from the mixing chamber be compelled to pass from the mixing chamber to the settling basins through small gates and restricted and tortuous passages, the coagulated matter will be broken up and the action of the mixing chamber be partially or completely nullified.

If, on the contrary, the water be permitted to flow into the settling basins through large and straight openings in a quiet and undisturbed velocity, the some are not as good as they might be.

With such flocculated matter in good full benefit of the mixing chamber can be obtained. Most designs show very satisfactory care of this feature, though condition, it should settle out very rapidly and completely in the settling basins, if they be well designed. But here we find one of the weak points. In dozens of plants, the settling basins show very indifferent results, some being exceptionally low. It is really amazing how many plants are found wanting in this respect.

Broadly speaking, we doubt whether the settling basins of recent design, are superior to those designed ten or more years ago. On the whole, we doubt whether any progress has been made in this important feature of design. Certainly some plants obtain worse results today than any we knew of ten years ago of similar pretensions to good design.

Certainly also some recent designs appear to have been made without sufficient study of the relationship of flow zone to sludge zone, while on the other hand this feature is very skillfully handled in some few designs. Deep basins, at least deeper than desirable, continue to be found in some designs, where much better results would be attained by shallower basins of equal displacement, and cross sections of more careful design and greater freedom and skill in utilizing baffles, with particular care regarding the open ends. Holding no brief for Allen Hazen, his excellent work on this subject has never received the attention or observance that it deserves.

STATUS OF FILTRATION

As much care should be employed in conducting the water from the settling basins into the filters as in leading it out of the mixing chamber into the settling basins. A fair percentage of recent designs show care in handling this detail; only a few appear to disregard it.

In the filter itself, we can note no material betterment in design and this is a conservatively modest statement. The large number of plants experiencing difficulties from mud balls, cracked beds, hard spots and low filtration efficiencies is worthy of attention, yet it appears to excite no particular attention.

Practically every grief of the modern filter is due, primarily, to faulty washing. It would be an exaggeration to say that every modern filter unit shows the evil results of faulty washing. There

About the Author

C. ARTHUR BROWN, whose paper on water purification methods is concluded in this issue, writes from an experience of over thirty years. In 1896 he took charge of the experimental filter for the O. H. Jewell Filter Co., of Chicago, in the famous experimental work on filtration conducted in Louisville, Kentutcky. In the latter part of that year he took charge of the construction of the Lorain, Ohio, filter plant and conducted its official test in which he established a world's record, the Lorain plant being the first in history to effect better than a 98 per cent removal of bacterial content in and under practical working conditions.

Mr. Brown designed and constructed the Oberlin, Ohio, softening plant, the first municipal plant in the United States to completely soften a city water supply. The Oberlin plant was also provided with a mixing chamber, designed by Mr. Brown, which has served as the basis of design for the present types of mixing chambers.

In 1904 Mr. Brown joined the American Steel & Wire Co. as chief engineer, a position he still holds. During the years from 1904 to the present he has had charge of about 225 municipal and over 300 commercial water purification plants for longer and shorter periods of time. In 1914-15 he prepared for the company the copy of the Manual of Water Purification, a book of 150 pages, which is still in issue and is widely circulated.

In conjunction with the Norwood Engineering Company, Mr. Brown designed the Bubbly Creek plant of the Union Stock Yards, Chicago, the first plant to purify a water as badly polluted as that of the outlet of the 39th St. sewer. In 1911-12 he designed the Fargo, N. Dakota, softening and purification plant, and in 1914-15 designed the Tulsa, Oklahoma, plant and conducted the official test.

In 1924 Mr. Brown conducted an extensive survey, covering 56 square miles, and submitted two reports, the first dealing with a water supply and the other with a power supply for the city of Waco, Texas. He is the author of many papers dealing with various phases of his subject, and has taken out a number of patents in relation to processes and equipment for water purification plants, including control, indication, integration and recording of fluid flows.

are some filters which do not; some are really completely and perfectly washed, so far as we are able to judge. We believe, however, that a complete survey of existing plants would show that more than fifty per cent of the plants constructed within the last ten or twelve years have had trouble resulting from incomplete and imperfect washings.

It is not believed that this imperfect washing is due to lack of care or inability on the part of the operator but on the contrary that it is due almost entirely to the design and construction of the modern filter; in other words, it is the engineering and not the operation of the plant that is at fault.

In the old standard units of the Jewell or Warren type, employing mechanical rakes which were driven through the sand bed while the bed was being washed, such difficulties were never even heard of. In these old units, filtration efficiencies per se were higher than those of the modern filter unit, due, we believe, to the more perfect washing system employed in these old filters.

Problem Is to Perfect Design

If a filter cannot be perfectly cleaned every time it is washed, it should not be very difficult to perceive that it will eventually become so clogged with accumulations as to show the effects of mud balls, cracked beds, hard spots and decreasing efficiencies in filtration. The fact that these difficulties are being experienced in so many plants, under so many different conditions of water supply, and methods of handling and under operators of so many different degrees of ability, tends to prove that it is in the design and not the operation that we should look for the explanation.

One of the worst phases of the matter, as we see it, is that so little attention appears to be paid to these difficulties. Apparently, in many plants, even some of the largest and most expensive, it is accepted as a matter of course and at more or less regular intervals the beds are dug up, washed and rebuilt, with no great effort, if any, to eliminate the cause.

In the meantime engineers, evidently dissatisfied with the results, continue to design different types of bottoms, assumedly in the belief that most of the trouble is attributable to the type of bottom used in the filters. It is probable that some of the difficulties can be legitimately ascribed to the types of bottoms in use. Some engineers, however, are inclined to think that before the problem is solved a number of other factors will have to receive consideration. It is the judgment of such engineers that some one type of bottom will finally be found which will have distinct advantages over all others, but even so, when such type shall have been found, it will prove only a partial solution and demand other and perhaps very radical changes in other details before this final solution may be deemed a certainty.

Filtration Experiments

It would appear that a considerable amount of research and experimental work will be required before these troubles can be overcome and filtration efficiencies brought up to the standard they should possess. It is and will continue to be of great interest to all to watch the results of the experimental work being carried on at Detroit and Chicago.

Both these cities have arranged to conduct experimental filtration work.

C. ARTHUR BROWN

Author of the accompanying paper and chief engineer, Engineering Bureau of Water Purification, American Steel and Wire Company.

In striking contrast to the filter per se, the equipment for the filter shows a very great advance in nearly every particular. In appearance it is vastly better in almost every detail. It is better designed and functions better and more smoothly. It is made of better materials and has greater durability.

Pleasing Appearance Is Sought

Concomitant with the improvement in the equipment has come also a much more general appreciation of the desirability of greater attention to detail and ornamentation of the plant itself and its surroundings. Landscaping and architecture are better and the inside appearance of plants generally has been vastly bettered. The trend seems to lie strongly in this direction and we hope to see it continue.

In the early days of filtration only one process was available. In 1896-7, at Louisville, the famous experiments under the supervision of George W. Fuller were conducted, the writer participating therein as the representative of one of the competing companies. These were the first tests to demonstrate conclusively the ability of the mechanical filter to maintain continuously and consistently a uniform high efficiency of bacterial removal and complete removal of turbidity even in waters carrying as high turbidity as that of the Ohio River at Louisville. The only results meeting the approval of those participating in these tests were obtained by the use of alum.

For five years thereafter the alum process underwent development before any materially different process was used to purify a municipal water supply. During this time more and more plants were built and data as to the limitations slowly accumulated.

Clarification and bacterial removal were the main ends sought and attained, although color removal began to be a desideratum.

Softening Dates from 1901

In 1901-2, the writer designed and built at Oberlin, Ohio, the first plant in the United States to effect the complete softening of a municipal water supply. This being the first plant of this type to be built, there was nothing to guide us and the plans for the work just naturally were entirely original but it is interesting to note that even at this early date and for the first time in the history of the art, there was provided a mixing chamber, practically of the same design as some of our present day mixing chambers.

This mixing chamber consisted of a wrought iron box containing numerous baffles which compelled the water to be violently agitated in its passage through the mixer, the chemical treatment of caustic lime and soda ash being added to the water immediately before the flow entered the mixing chamber. This mixing chamber was under a low pressure and not open to atmosphere.

This plant was very satisfactory. It supplied the city with a softened and filtered water for many years after its installation and the complete removal of all sulphate hardness and most of the temporary or carbonate hardness changed the Oberlin water supply from one of dubious value to a supply which was the envy of many another city and led, shortly thereafter, to the construction of a number of other plants to soften their

water supplies. The Oberlin plant reduces the hardness of the raw water from a little over 200 P.P.M. to less than 50 P.P.M. and was successful in operation from the beginning, thus proving the feasibility of completely softening a municipal water supply.

About the time the Oberlin plant was designed, the process of sulphite of iron was introduced at a number of plants, meeting with fair success but proving rather short lived ,being replaced shortly after its introduction by sulphate of iron.

This process came into use in 1903-4, and shortly thereafter was adopted by a considerable number of cities. It remains today as one of the standard processes, being better adapted to certain waters and conditions than any other process.

Recarbonating Overcomes a Difficulty

One of the objections to softening processes is found in the tendency of the water to form incrustations under conditions not well understood. A longer experience with such processes abroad proved this trouble could be overcome by recarbonating the water and converting the subcarbonates and monocarbonates to a bicarbonated state by the addition of carbon dioxide to the water after softening had been effected.

For some reason or other this was not tried out in this country for a number of years after softening plants became well known, but in the last several years a number of these recarbonating plants have come into use and the results attained justify their employment. It is probable that the future will see more of the plants, of simpler construction and lower cost.

Decarbonating Corrosive Waters

Exactly opposed to the preceding is the practice of decarbonating. It has been found by Bayliss that when the Ph value of a water happens to be just right, such water is highly corrosive, tending to destroy mains and services and to produce the familiar "red water" so commonly known in many sections of the country. Not only may this condition be found in some natural waters which have undergone no chemical treatment, but it may be produced in waters by chemical treatment or a natural water having low corrosive effect may have its corrosive quality much augmented by chemical treatment.

Any treatment, such as alum, which releases carbonic acid, will augment and intensify the corrosive effect of many water supplies.

The annual loss from such corrosive action is startling. Bayliss states it has been estimated at $5,000,000.00 per annum for New York City alone, with more or less proportionately high annual losses for other large cities. As we recall it, the loss at Baltimore was estimated at over $3,000,000.00 per annum.

Bayliss found this could be corrected for at Baltimore by adding caustic lime to the water after filtration has been completed to a point where the Ph value would be brought to that which would insure a water of non-corrosive quality. It would appear that while it may take a little time for this idea to take root, it is very likely that such a sane and sensible suggestion must ultimately result in a large number of cities using this method to better their water supply. New York could well afford to do this right now and numerous other cities are only better off because they are smaller. Proportionately to their population, some are worse off.

Double Treatment Tried

Another variation in chemical practice which may or may not find acceptance is now being tried out at Cincinnati. This consists of a double treatment. Where large units for preliminary settling are available, it may prove advantageous to treat the water entering the preliminary settling basins with a small chemical treatment in advance of the secondary and larger treatment to be given at the time the water is about to be introduced into the settling basins proper. Mr. Bahlmann, in charge of this experimental work at Cincinnati, is a very competent investigator and his results will be awaited with much interest.

The use of chlorine has become well nigh universal. It is doubtful if such usage can be carried much further. Some engineers believe it has been carried too far. Of these, the writer is one. Many operators believe that any failure in filtration can be corrected for by a little freer use of chlorine. It may be that some of the difficulties discussed under filters are in part attributable to the use of chlorine.

It is easy to see that as long as a filter will turn out a fairly sightly product and any bacterial inefficiency may be covered up by a little larger use of chlorine than would otherwise obtain, there is a certain incentive to use the chlorine and let the filter go until the condition gets so bad that it will no longer produce results which can be tolerated. To argue that a conscientious operator would not do this gets us nowhere as we know that all operators are not skilled and may get into this trouble without really knowing just what they are doing. Furthermore, all operators are not conscientious, although it is surprising how many are.

Be that as it may, it is difficult to see how the use of chlorine can be extended much more than it now is and it is to be expected that its use will remain about as it is.

Trend of Design

In this brief survey of the present state of the art we may note certain very significant changes, which may mean much more than a casual reading would indicate as to their ultimate effect upon the trend of methods in this field.

Generally speaking, the trend appears to be towards a more ornate and pleasing type of architecture for the plant itself and a tendency to dress up the surroundings and render them more in keeping with the improved appearance of the plant. This same tendency is reflected in the interior in more attention to the details of finish and ornamentation, in more and better equipment of better appearance as well as operation, and in the care and upkeep all the way through.

Generally speaking, little progress is to be noted as a whole, in the design of the particular units or parts going to make up the plant as a whole nor have efficiencies increased in the plant as a whole, while they may have suffered in some particulars.

In equipment the change is marked for the better. More and better equipment is provided and further betterment in this phase is to be expected to continue, the change in the next ten years being probably in keeping with or possibly excelling that of the last ten years.

The most significant and vital changes noted and those probably indicative of much more vital ones to come are to be found in the changing processes and increasingly higher standards for purified water.

Higher Standards of Purity

As new processes become available and their results known, it is reasonable to expect standards of purity to be altered also. Already the demands of the public health officials are much more stringent than they were ten years ago and it is reasonable to expect the demands to become more stringent in the future. Where this will end, eventually, we need not worry over now.

There is little doubt that if settling basin efficiencies and filter efficiencies had been materially increased in the last ten years, the standards for filtered water would have been even higher than they now are. It is reasonable to expect the change in standards to become stricter and stricter as the ability to produce better and better water becomes more certain and universal.

The change in processes indicates the

(*Continued on Page 58*)

METERS & METERING

How the Current Meter Is Used to Explore and Repair Leaky Artesian Wells

While the Principle Involved Is Simple the Method Employed Is Considered an Advance in Well Management

THE value of a current meter in exploring and repairing leaky artesian wells is described by Oscar E. Meinzer, of the Geological Survey, Department of the Interior, in a preface to papers by John McCombs and Albert G. Fiedler, just issued by the Survey.

The method has been successfully used in the main artesian areas on the island of Oahu, Hawaii, and in the Roswell artesian basin, in the Pecos Valley, N. Mex., according to Mr. Meinzer.

The full text of the statement by Mr. Meinzer follows:

The use of a current meter to explore wells, as described in the papers by McCombs and Fiedler, is a distinct advance in methods both of hydrologic research and of practical well management. So far as I am informed, this method was first used successfully in 1918, by R. D. Klise, of the United States Geological Survey, in a study of the artesian wells of Honolulu.

Principle Is Simple

The principle involved is very simple. The meter is let down into the well, where it records the velocity of the water at any depth desired; with the velocity and the diameter of the well known, the rate of flow at any point can be determined. Hence, a series of measurements taken at successive levels from the bottom to the top of the well will show just where the water enters and in what amounts, where it leaks out and in what amounts, and how much is delivered at the surface. For certain investigations it may be necessary to devise apparatus for measuring the diameter of a well at any depth, but thus far no serious difficulties have arisen on account of uncertainty as to the diameter.

This method has now been successfully used in the main artesian areas on the island of Oahu and in the Roswell artesian basin, in the Pecos Valley, N. Mex. In both of these areas the problem has been to ascertain the quantity of artesian water that is wasted by leakage from the wells at nonartesian horizons. The exploration of an artesian well is of immediate practical value to the well owner in giving him definite and reliable information as to whether any leaks occur in his well; if so, at what depths and in what amounts and about how much the yield can be increased by recasing. Moreover, the exploration of all or a considerable proportion of the wells of an artesian basin furnishes essential data to the investigator who is charged with the duty of making an inventory of the artesian water supply of the basin for the purpose of bringing about the maximum beneficial use without harmful overdevelopment.

I believe the current meter will eventually be used also in exploring pump wells to determine the horizons at which water enters the wells. In wells that extend through beds permeated with salt water it may, however, be more practicable to detect leaks of salt water into the wells by chemical or electrolytic methods.

Tests in New Mexico

The value of the current meter in exploring wells has been impressed on me by my experience in the Roswell artesian basin of New Mexico. In 1916 I spent about 10 days in the Pecos Valley near Roswell planning an investigation of its artesian-water supply.

At that time the artesian pressure had already declined greatly, and many ranches along the margin of the original area of artesian flow had been abandoned because the water level in the wells had gone too low for profitable pumping. There was much local discussion and difference of opinion as to whether the decline in artesian pressure was due to overdevelopment or to subterranean leakage out of the wells through corroded or defective casings, but almost no definite information was available concerning this very vital question.

I had taken with me a Price current meter and some equipment for inserting it into flowing wells. In the preliminary tests which I was able to make I did not succeed in getting any information as to leakage, but I was convinced that with more substantial equipment it would be feasible to explore flowing wells for underground leakage with a current meter.

On account of the World War and other conditions, the investigation in the Roswell artesian basin had to be postponed until 1925, when it was taken up by Mr. Fiedler. He was provided with a current meter designed especially by Carl H. Au for use in exploring deep wells. The first flowing well to be explored was an old well 932 feet deep that was suspected of leaking. The meter was let down about 25 feet at a time and readings were made at each level. The readings showed that the current increased from the bottom to about the 785-foot level, and that from this level to the top it was nearly constant at about 3.80 feet a second, or 605 gallons a minute, proving that the casing was not leaking at any point.

In other wells, as described by Mr. Fiedler in this report, leaks of various kinds were found, the position of each leak was determined, and the quantity of artesian water wasted through it was measured or estimated. Thus the underground waste of artesian water need no longer be a matter of mere opinion, as the facts can be definitely determined by exploring each well.

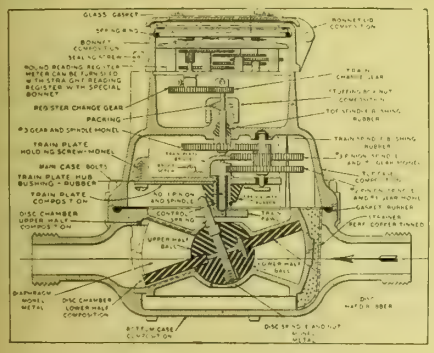
For the work in Honolulu the Price current meter was used, although it was recognized that this meter was not designed for this purpose. For the work in New Mexico, the special deep-well meter is giving good service. The outer jacket of this meter is a 3-inch pipe, but Mr. Au is at present working on a meter of still smaller diameter. The methods of lowering the meter in the New Mexico work are more rapid than those used in the Honolulu work. Where large leaks are encountered special precautions have to be taken to prevent the meter from being carried out of the well by the outward current.

On account of the great value of the artesian-water supply in the Honolulu district it was wise public policy to carry out a somewhat expensive program of thorough recasing or plugging all leaky artesian wells. Great credit is due to the governor and the legislature for authorizing this vital program of conservation and to Mr. McCombs and his colaborers for carrying it out so effectively. The value of the work already completed is indicated by the fact that the leakage which has been stopped is equal to more than one-fourth of the total quantity of artesian water used for the public supply of Honolulu.

Use of Meters Grows as Water Becomes Ever Scarcer

Improvements in Design Keep Pace With Increase in Number Used

Public utilities, water companies, and water distributors of all kinds have come to realize that one of their most important operations is the metering of the fluid that they sell. With this fact in view, the manufacturer of water meters has striven to keep abreast of developments and to provide the water company with an instrument that will give maximum service and reliability with minimum attention. These changes in the design of water meters for domestic and industrial service lines have been made



Cut open model of the new Worthington water meter. Train gears are full monel metal.

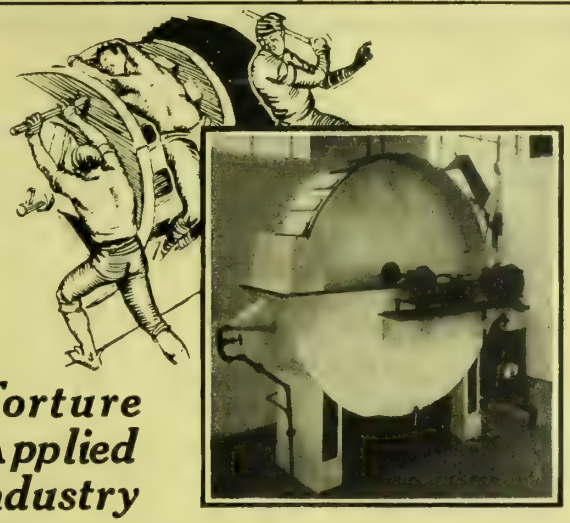
for the benefit of both the service company and the consumer.

Only a short time ago all water sold in California was upon a flat rate basis, no meters being used with the possible exception of a few master meters to give the service company some idea of just what their operations were. As water became scarce, a greater number of consumers demanded service, and as the companies had to expend large amounts of money to provide this additional service, it became necessary to meter all the water used. At the present time the greater portion of all water used in California is metered and an accurate account is kept of the amount delivered to each individual consumer.

Increase Is General

This condition of water scarcity is not confined alone to California or to the western states but is more or less general throughout the country. Middle western cities, which have heretofore been upon a flat rate basis, are now installing meters. An engineer interested in waterworks supply equipment, who has recently returned from a trip through the east, makes the statement that at least eight of the larger eastern cities which have been on a flat rate basis are now

(*Continued on Page 36*)



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STORAGE & DISTRIBUTION

Port Townsend, Wash., Plans New System For Distribution of City's Water

Engineers' Report Shows That Eighty-Five Per Cent is Lost Through Leakage and Waste in Present Lay-Out

THAT the present water system of the city of Port Townsend, Washington, has passed the age when it can be much longer depended upon for serving its purpose, and that some definite plan of action must at once be determined upon for relieving the situation, must be adopted and put into effect, is voiced in the report of Messrs. Jacobs and Ober, the engineering firm of Seattle, who were some time ago instructed to make a thorough investigation of the system and present a report of their findings and conclusions. Several plans for the reconstruction of the water system were offered, and the one which Mr. Ober believed would prove the least expensive and financed with the least difficulty, was that of pumping water from wells for city requirements, should it be demonstrated that it exists in sufficient quantity, a matter which would have to be proved before any work of construction would be started. The purity of this water has been demonstrated, and while it is hard water, if found advisable, a softening plant could be installed if necessary.

Parts of the recommendation and findings included in the summary of the report are as follows:

Engineers' Recommendation

That the city of Port Townsend should, without delay, determine upon the plan to be adopted for the reconstruction and rehabilitation of its water supply system, and having determined upon this plan, it should proceed diligently in conformity therewith.

That the principal issue to be decided is whether or not the city shall reconstruct its gravity supply system, involving a material increase in its rates, whether it will adopt the plan of pumping water from wells, with no increase or only a small increase, in present rates.

Assuming that the recommended tests as to the quality and sufficiency of the well water supply, which tests are a necessary prerequisite, prove this water to be satisfactory, as we anticipate it will, then it is our judgment that the most feasible and practical plan for the solution of your problem, under present conditions, is the adoption of the pumping plan and this recommendation holds whether or not a water softening plant is provided.

We recommend a cast iron distributing system in connection with this plan. It is entirely evident from our analysis that a pumping plant can economically serve the community for the life period of the plant and need not prevent a return to a gravity system when a larger population and other more favorable conditions would make its adoption a lesser financial burden to bear.

If Wells Fail

Should the tests prove the wells to be unsatisfactory as a source of supply, and the city compelled to reconstruct the gravity system, depending upon the favorability of the financial arrangements that can be made, our recommendations in order of their preference are as follows:

1. A creosoted wood pipe supply main and a cast iron distribution system.
2. An untreated wood pipe supply main and a cast iron pipe distribution system.
3. A creosoted wood pipe supply line and an untreated wood pipe distributing system.
4. Untreated wood pipe throughout.

Whether the pumping or gravity plan is adopted, the city should proceed promptly with the arrangements for making the necessary surveys, the preparation of plans and specifications, the calling for bids and the prosecution of construction.

That all services in the entire system be metered, and that a monthly rental charge be made for each meter.

That a compound meter be installed in the Fort Worden 8-inch supply line, in order to provide for accurate registration of the amount of water used at Fort Worden. It is believed that the present meter does not register the full amount of water passing through it, especially during times of light consumption. The present meter should be left in place for some time, in order to establish the rate of delivery which obtains.

That no use be made of the City Lake reservoir except in cases of emergency, as its permanent use for storage purposes is not required under present conditions, nor those anticipated in the reasonably near future, and its use would result in the impairment of the quality of the water supplied to the city. We do, however, recommend that the city continue to hold this reservoir as of possible future use as discussed in the main body of this report.

That steps be taken to secure an adequate return for water used by the McCormick Lumber Company.

That the main supply line has nearly reached the limit of its useful life, considered as a whole. Certain sections which are in very bad condition should be rebuilt as early as possible. Other sections, with necessary repairs, may be continued in service for a few years longer.

The older portions of the distributing system have nearly reached the limit of their useful life, and a considerable portion should be rebuilt as soon as practicable. Other portions, particularly those which were built at a later date, may be continued for some years, but the entire system should be rebuilt within the next ten years.

Other Repairs Suggested

The intake dams are in fair condition and require minor repairs only to keep them in service, except as to the Rixon Creek intake, which should be replaced with a permanent structure.

The older reservoir in Port Townsend requires extensive repairs and this work should be done without delay in order to provide storage during the low water period.

The loss of water by leakage at the intake dams is considerable, amounting to approximately 500,000 gallons per day in October.

The leakage from the main supply line was found to be at the rate of approximately 950,000 gallons per day.

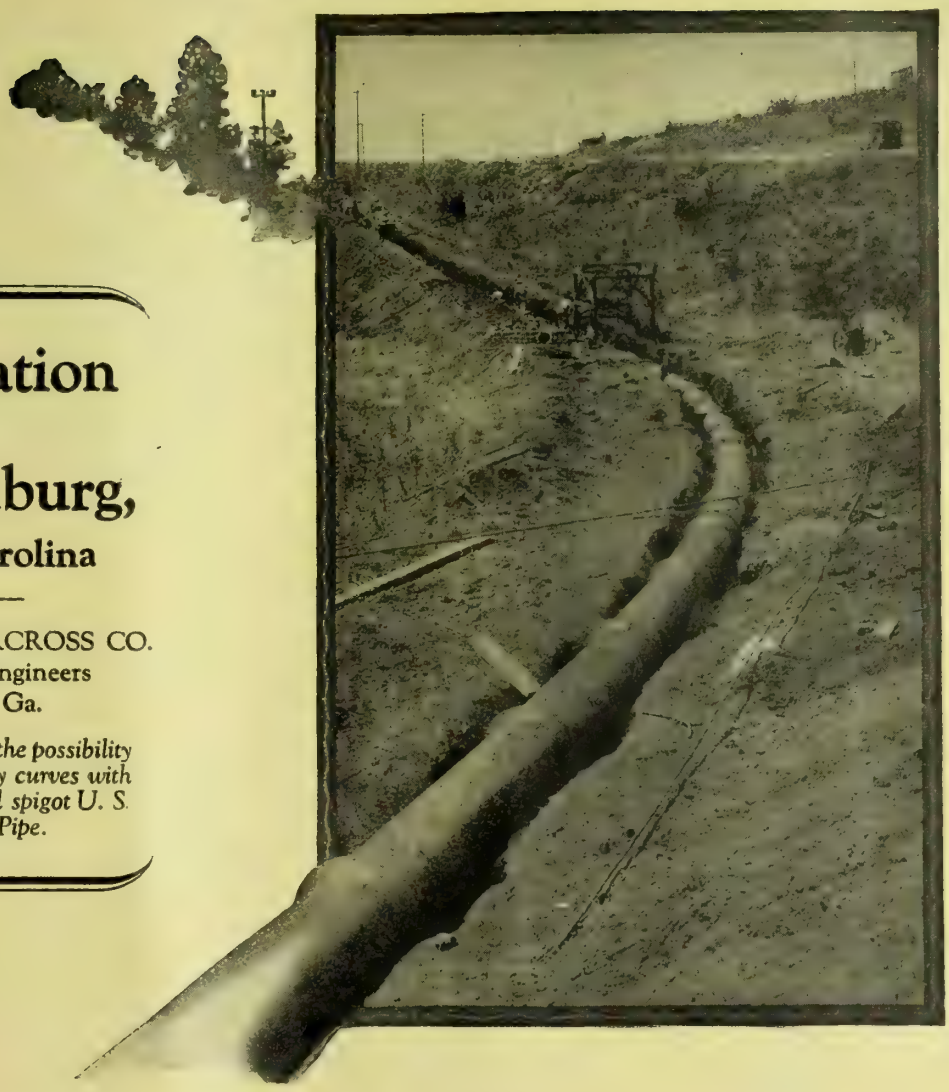
The leakage from the Port Townsend distribution system was found to be approximately 350,000 gallons per day. Various other enormous leakages were cited in the report.

The loss by waste from service in Port Townsend and Fort Worden was found to be approximately 230,000 gallons per day.

The total loss by leakage and waste from the entire system, exclusive of surplus used at Chetzemoka Park, was found in October, approximately 2,300,000 gallons per day, or about 85 per cent of the entire flow of Snow Creek, Trapper Creek and Rixon Creek at that time.

Minimum Flow Sufficient

The minimum available flow at the intake dams from Snow Creek, Trapper



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Creek, Rixon Creek and a small unnamed stream below Snow Creek dam, is estimated to be at the rate of 2.17 cubic feet per sound, or 1,400,000 gallons per day. The average flow for a minimum seven-day period is estimated to be 2.36 second feet, or approximately 1,500,000 gallons per day. The average flow, for a minimum one-month period, is estimated to be 4 second feet, or approximately 2,600,000 gallons per day.

The minimum flow of these streams is sufficient for all requirements of Port Townsend and Fort Worden at times of maximum demand, according to the forecast of population, for all years up to 1960, without any storage other than that provided by the existing reservoirs in Port Townsend, providing that all services be metered, nor is any storage required during this period, even if the water is furnished to Hadlock, Irondale and consumers along the main supply line which should also be fully metered. These statements are predicated on the assumption that the pipe lines will be so maintained as to prevent excessive leakage.

The estimated cost of reconstructing the main supply line varies from a minimum of approximately $176,000 to a maximum of $264,000, on a bond issue basis, depending upon sizes and kinds of pipe which may be used. The capacity of the main supply line as estimated above is sufficient to provide for a population varying from 4000 as a minimum to 15,000 as a maximum, for fully metered services, and from 2600 minimum to 9300 at a maximum for partially metered services, based on an average rate of leakage from the entire system not to exceed 1000 per gallons per inch diameter of pipe per mile per day.

Use of Water Meters Growing

(*Continued from Page 33*)

installing meters, of such a type as will be best suited to their particular needs.

The Worthington Pump and Machinery Company manufacture a meter of the disk type, which is furnished with open train gears or closed oil train gears. This meter is extensively used by water supply companies upon their domestic service lines. Current conditions have been clearly reflected in the operations of this company. They have recently completed an addition to their factory which will allow an increased production of approximately 40 per cent.

The Worthington Company is now manufacturing a meter which is slightly different from the old type heretofore used. This new instrument is equipped with a train gear system made of monel metal, and these gears are enclosed in a waterproof case. Heavy oil or grease is placed around the gears, which, with the special metal of which they are made, gives double protection from the corrosive action of the water. Another improvement is the use of high grade naval bronze case bolts instead of the galvanized bolts formerly used. This eliminates corrosion at this point and tends to make the meter stronger and less liable to replacement.

The Worthington Company has been very successful in its operations on the Pacific Coast, and it is reported that they have recently made some large installations at many points within this territory. The company maintains western distribution centers at Los Angeles, San Francisco and Seattle. In each of these cities there is also a service department which takes care of the maintenance and repair of such instruments as are sent them by the users.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

Of Modern Irrigation published monthly at Los Angeles, California, for April, 1927.

State of California, } ss.
County of Los Angeles. }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Walter C. Monroe, who, having been duly sworn according to law, deposes and says that he is the Vice-President of the Modern Irrigation and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher—Petroleum World Publishing Company, 626 S. Spring St., Los Angeles, Cal.

Editor—Russell R. Palmer, 626 S. Spring St., Los Angeles, Cal.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addreses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)

Owen Brown, President, 626 S. Spring St., Los Angeles, Calif.

Walter C. Monroe, Vice-President, 626 S. Spring St., Los Angeles, Calif.

Minor Moore, Secretary, Stock Exchange Building, Los Angeles, Calif.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is.....
(This information is required from daily publications only.)

Sworn to and subscribed before me this 6th day of April, 1927.

(SEAL) JOHN SCHUMACHER,

Notary Public in and for the County of Los Angeles, State of California.

My commission expires February 17, 1930.

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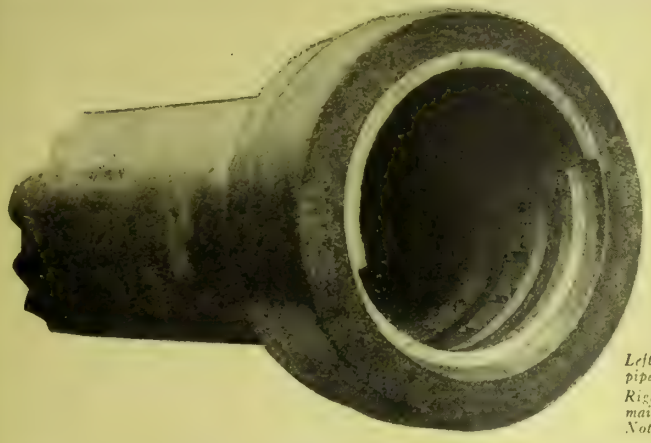

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WATER PURIFICATION

Elimination of Colloidal Interference by the Use of the Aluminate-Alum Method of Coagulation

By F. H. THORNE*

TO UNDERSTAND thoroughly the principles involved in the use of the sodium aluminate-alum combination for coagulation in the clarification of industrial and city water supplies, it is necessary to briefly note some of the phenomena of application of these reagents.

Filter alum or aluminum sulphate, ordinarily reacts with the calcium bicarbonate present in the natural water to form calcium sulphate, aluminum hydroxide and carbon dioxide. Recent discussion has tended toward an effort to disprove the formation of aluminum hydroxide in this reaction, but for the purposes of this paper we need not question this phase of the matter. In this equation, the amount of alum that will react to produce the aluminum hydroxide coagulum is dependent upon the amount of alkalinity present in the water. When the amount of alkalinity present in the natural water is insufficient to react with all the alum required to produce sufficient coagulum to remove all color, turbidity and bacteria, calcium hydrate or sodium hydrate or carbonate are frequently added to assist the natural alkalinity in this reaction. Also, when the amount of free CO_2 formed by reaction between alum and the natural alkalinity becomes sufficient to become a menace from the standpoint of corrosive tendencies of the water, then, frequently the addition of lime or soda ash is resorted to. It is not the purpose of this paper to go into any of the objections to these methods such as the after reaction and the need for recarbonization.

Rules Fail in Practice

Theoretically, these reactions should progress to practical completion in a very short time, dependent only on the general laws of mass action. Also, coagulation and efficient clarification should demand the addition of sufficient alum only to produce the requisite amount of coagulum for the removal of color, turbidity and bacteria. Were these theories practically applicable we should be able to plot a curve showing the actual alum requirements for a given amount of a specified type of material to be removed. In practical water clarification, however, we find that these simple rules frequently if not generally fail to meet the case.

The presence of colloids, both mineral and organic, existing as color or turbidity seem to exert strange influences upon the normal reactions of the alum. At times, the addition of calcium or sodium hyrates "set" the color; again they assist in its removal. In some cases the addition of certain acids aids in colloid removal; in other cases it retards the action. In some cases it is found absolutely necessary to bring the water to a definite pH value before coagulation and clarification can take place. In other cases coagulation will take place efficiently entirely independent of pH value. These various conflictions have given rise to numerous theories, some of which are applicable to one case and some to another. These phenomena are interesting and considerable valuable work has been done in an endeavor to establish definite rules to cover them. The primary difficulty seems to lie in the fact that the phenomena differ so radically in different waters and even from period to period in the same water.

Where Method Is Feasible

It was with the purpose of offsetting these inhibitory influences that the sodium aluminate-alum method of coagulation was developed. Inasmuch as all natural waters do not contain inhibitory colloids it is quite obvious that the aluminate-alum method is not indicated in every case of water clarification. It is true that this method seems to have advantages in the production of non-corrosive water, but that is a separate subject. Although the use of a small quantity of sodium aluminate will invariably reduce the required alum dosage, it is not economically feasible to use this method unless the alum dosage required for any given water is in excess of that required strictly for the production of sufficient coagulum for the removal of the undesired foreign matter.

The reaction of alum with the natural or artificial alkalinity depends upon the exchange of the sulphate radical possessed by the alum for the hydroxyl radical possessed by the alkaline salt. Now, if there are present in the water charged colloids having an attraction for an opposite charge, these colloids may absorb ions containing this missing charge, to the satisfaction of their requirements and to the inhibition of the normal alum-alkali reaction. Inasmuch as these colloids may be positively or negatively charged and in some cases both may be existent in the same water in constantly varying amounts, it is a practical impossibility to calculate the alum requirements by analytical methods. Even though the amounts and nature of the colloids be relatively constant so that the alum dosage can be determined by experimentation, the fact still remains that their presence calls for the use of excessive amounts of reagents.

Negative Colloid Predominates

In the water examined throughout the

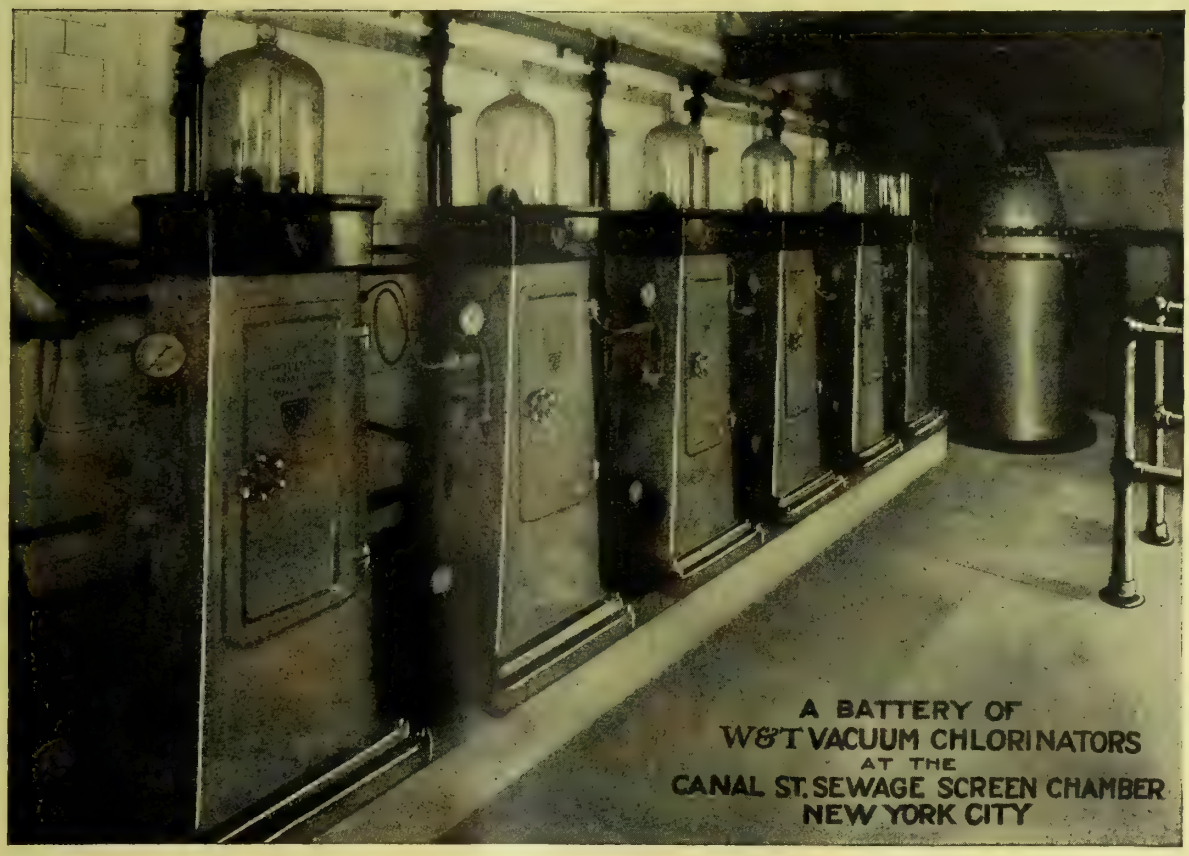
*Field Manager, Chicago Chemical Co.

Author's Note

In examining the research work done by filtration engineers in the past, it is notable that in almost every instance the work has been done on only one water and in only one plant by each chemist. Since much of the work has been done by operators who had access to only one plant, they could scarcely have done otherwise, and yet this method has frequently clouded the real facts and led to erroneous conclusions.

Realizing the need and desirability of absolutely proven fundamental facts, the Chicago Chemical Company has decided to try and establish all theories beyond question before stating them as facts. With this idea in view, and although the aluminate-alum method for the elimination of colloidal interference has seemingly been proven in about a dozen different waters, yet it is published now merely as a working theory.

This organization will be pleased to hear from any operators having a water which seems to come under this classification. We will be glad to do any experimental work in our own research laboratories, or we will conduct laboratory or plant tests in any locality where such waters are present. By thus coming into intimate contact with a large number of different waters, this theory will either be definitely proven to the advantage of the profession as a whole, or in the event that it is disproven the work may uncover valuable fundamental principles. We ask the co-operation of the profession in this work and are ready and willing to co-operate in any research on water clarification in every way possible.



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United States, the negatively charged colloid has been in the preponderance and the positively charged colloid has been met with comparatively seldom. If the colloid has a negative charge we find that the addition of calcium or sodium alkalies has the tendency to still further inhibit the alum reaction. In this case we find that the addition of acid up to a certain point will assist coagulation and decrease the amount of alum required. In fact, in some cases the addition of acid alone will actually precipitate the colloids. This is evidence that an actual reaction occurs between the colloid and the acid added to form a suspended particle. In these cases we find it necessary to operate at a definite pH datum point. The pH datum or optimum point varies, however, in direct ratio to the amount and type of the colloid in the water. Much the same theory holds good in the case of positively charged colloids except that in this case we find that the addition of an alkali is a distinct aid to coagulation and the acid becomes an inhibiting factor.

Briefly, then, we might say that the alum or alum-lime reaction in the presence of charged colloids cannot progress until the demands of the colloid have been satisfied. A careful study of the hydrogen-ion concentration changes under this method will clearly demonstrate that fact.

However, when we introduce a small amount of a reagent such as sodium aluminate, which, on account of its very instability exists in a very slightly ionized form, we find that the slightest upset in its equilibrium will cause its decomposition with the resulting formation of aluminum hydroxide and sodium hydroxide. The aluminum hydroxide so formed acts as a nucleus around which further aluminum hydroxide is formed by reaction between the balance of the alum and the sodium hydroxide and between the alum and the natural alkalinity. This phenomenon forms the basis of the aluminate-alum theory. It is distinctly noticeable that the sodium aluminate so used must be in solution or else be put in true solution. It is also noticeable that if the sodium aluminate solution contains too great an excess of sodium hydroxide, this phenomenon will not take place and the results obtained will be on a par with those obtained by the use of alum and sodium hydroxide. Again examining the pH value changes and taking into consideration the greatly reduced quantities of reagents used, it is quite evident that under this method no reaction takes place involving the colloid. Formation of the floc is obtained as outlined and from that point on the removal of colloidal and suspended matter is merely physical absorption or absorption by the floc.

The results obtained by this method indicate that the inhibitory influences can be completely offset and efficient coagulum produced independent of any conflicting ions.

A Case in Point

As a representative case, a water containing over 400 ppm of color required over 4 grains of alum plus sufficient acid to bring the pH value to 5.2. Coagulation was obtained at no other pH value. When less than ½ grain of sodium aluminate was added the required alum dosage was reduced about 50 per cent and coagulation could be obtained at any desired pH point without the aid of any acid.

In another case the natural water had a pH value of 7.55. Coagulation was obtained by 2.3 grains of alum and 0.5 grains of lime with a resulting pH of 7.25. A combination of 0.3 grains sodium aluminate and 1.0 grains of alum was tried. This resulted in a water of 7.9 pH and having equal qualities as to color, turbidity, etc., with the first treatment. Inasmuch as the amount of OH radical present in the aluminate-alum dosage was less than in the alum-lime dosage it is interesting to note the variance in the pH values of the effluent in the two cases. In both cases the proportion of sulphate to hydroxyl was about the same.

In addition to the freedom from colloidal interference, this combination quite obviously reduces the amount of free CO_2 formed, first, through a reduction in the amount of alum required and second, due to the hydroxide content of the sodium aluminate. This phase should be distinctly advantageous in the elimination or reduction of corrosion.

Standards for Swimming Pools

(*Continued from Page 28*)

E. Sterilization of clear water may be obtained by exposure in thin films to ultra-violet rays. This sterilizing action is confined entirely to the period of such exposure and no residual disinfecting action is carried over into the pool. Disinfection, therefore, proceeds according to the law of purification by consecutive dilution and is subject to the limitations imposed by that law. There is never any disinfectant in the pool water to act on infectious material which may be discharged by bathers during the bathing period at the time when such material is most dangerous. In a few cases satisfactory control of the bacterial content of pool water has been reported by the use of ultra-violet disinfection alone. In a considerable number of instances, however, it has been found necessary to reinforce or supplement the ultra-violet treatment by treatment with chlorine or

hypochlorites. On the basis of any available evidence the committee cannot recommend the use of ultra-violet ray apparatus alone for disinfection of any pool where the bathing load is high or where large temporary loads are likely to occur.

F. Judging from a few reports, a reasonably satisfactory disinfection of water may be accomplished by ozone when the necessary apparatus is properly installed and operated. The data on the use of ozone for swimming pool disinfection are very few and inconclusive. There is no evidence that ozone has any residual sterilizing effect after the water has been treated, and disinfection must, therefore, proceed according to the law of consecutive dilution and be subject to all limitations imposed by that law. On the basis of any available evidence, the committee cannot recommend this method for swimming pool disinfection.

G. The committee recommends the use of copper sulphate in combination with either of the approved methods of disinfection at such times and in such amounts as may be necessary to control growths of algae in swimming pools and other bathing waters. The use of copper salts alone as a disinfectant will not produce satisfactory bacterial control and cannot be recommended.

Diving Towers and Spring Boards

A. Diving towers, when provided, shall be rigidly constructed and properly anchored to the bottom with sufficient bracing to insure stability under the heaviest possible load.

B. Fixed platforms and floats in the water shall be constructed with an air space of at least 1 foot beneath. There must be as little under water construction in such platforms as is consistent with strength, and all braces, struts, etc., shall be designed to prevent entanglement or trapping of bathers beneath the platform.

C. At least 12 feet free and unobstructed head room must be provided above diving boards and towers.

D. No diving board or platform more than 10 feet above water level should be permitted at any public place. The elevation of diving boards or towers should not exceed the safe limit for the average swimmer. The consensus of opinion of swimming instructors, etc., as summarized in the Fifth Report of this committee apparently establishes the following as the minimum safe depth of water for diving from various elevations:

Elevation of Diving Platform	*Minimum Safe Depth of Water*
1 foot	5 feet
3 feet	6 feet
5 feet	7 feet
7 feet	8 feet
10 feet	9 feet

Emergency Equipment

A. Pole hooks, ropes, buoys, and other necessary life saving equipment must be provided and be readily accessible at all pools and bathing beaches.

B. A first aid kit containing aromatic ammonia, tincture of iodine, sterile gauze, absorbent cotton, surgeons' plaster, and bandages of various widths should be provided for emergency use at all public bathing places.

Suits, Towels and Caps

A. At indoor pools used exclusively by men, nude bathing should be required. At indoor pools used exclusively by women bathing suits should be of the simplest type. Suits when used should be of wool or cotton of simple design and of undyed material or tested for fastness of color. Elaborate suits of varied materials or varied colors should not be permitted.

B. At artificial pools all bathers of both sexes should be required to wear rubber bathing caps.

C. It is desirable at artificial pools that all suits and towels be supplied and cared for by the management. If individually owned suits are permitted, they should be of prescribed style and material and should be laundered and stored at the pool by the management.

D. All suits and towels must be washed with soap and boiling water, rinsed, and thoroughly dried each time they are used.

E. Unless suits and towels are sent to a public laundry, the installation and use of modern laundry equipment at all public bath houses and pools should be required. Cold water washing and air drying should be prohibited. The use of a disinfectant on suits and towels in place of proper laundry methods is a makeshift which should not be permitted.

F. A sufficient number of suits and towels should be provided to take care of the maximum number of bathers. Unless thoroughly dried by artificial heat in a modern laundry drier, suits and towels should not be re-issued on the same day that they have been used.

G. Clean suits and towels must be kept strictly separated from those which have been used and unlaundered. Clean suits and towels must not be stored on shelves, handled in baskets or passed out over counters where dirty suits have been.

Supervision of Bathers

A. A swimming instructor, bathing master or other qualified attendant should be on duty at the pool side at all times when a pool is open to use by bathers. Such attendant should be in full charge of bathing and have authority to enforce all rules of safety and sanitation.

B. An attendant should be on duty at the shower room or entrance to the pool to inspect all bathers for skin diseases, open lesions, etc., and to insure that a proper cleansing bath has been taken.

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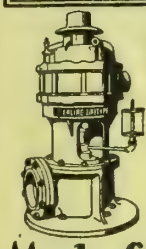
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C. At public bathing beaches one or more life guards should be on duty during all bathing hours.

D. Swimming pool attendants and life guards should be capable swimmers, competent in life saving methods and in methods of artificial resuscitation.

E. No bather should be permitted to enter the pool room or pool enclosure, unless an attendant or other competent person is present. Solo bathing must be absolutely prohibited at all pools.

F. Whenever a pool is empty, entrance of all persons except pool attendants must be effectually prevented.

Personal Regulations

A. All persons using a swimming pool must be required to take a cleansing shower bath in the nude, using warm water and soap, and thoroughly rinsing off all soap suds, before entering the pool room or enclosure. A bath after donning a bathing suit should not be permitted.

B. A bather leaving the pool room or enclosure for any reason should take a foot bath before returning. A bather leaving pool to use toilet should be required to take a second cleansing bath before returning.

C. All bathers should be instructed to use the toilet and particularly to empty the bladder before taking cleansing bath and entering the pool.

D. Any person having any skin disease, sore or inflamed eyes, cold, nasal or ear discharges, or any communicable disease must be excluded from a public swimming pool.

E. Persons having any considerable area of exposed sub-epidermal tissue, open blisters, cuts, etc., should be warned that these are likely to become infected and advised not to use the pool.

F. Spitting, spouting of water, blowing the nose, etc., in the pool should be strictly prohibited. Bathers should be instructed that the scum gutter is provided for expectoration.

G. All bathers should be instructed that blowing the nose to remove water is likely to force infectious matter into sinus and inner ear cavities and possibly cause serious consequences.

H. Divers should be advised to wear rubber caps over the ears or to plug the ears with greased cotton to prevent infection of the ear drum and passages by water forced in by concussion.

I. No boisterous or rough play, except supervised water sports should be permitted in the pool, on the runways, diving boards, floats, platforms, or in dressing rooms, shower rooms, etc.

J. Suitable placards embodying the above personal regulations and instructions and those relating to suits and towels should be conspicuously posted in the pool room or enclosure and in the dressing rooms and offices at all swimming pools. At a number of boys' club pools the boys are required to memorize the rules for safety and sanitation as a prerequisite to use of the pool.

Chemical and Physical Qualities

A. *Excess Chlorine:* Whenever chlorine, calcium hypochlorite or other chlorine compounds are used for swimming pool disinfection, the amount of available or excess chlorine in the water at all times when the pool is in use shall not be less than 0.1 p.p.m. nor more than 0.5 p.p.m.

B. *Acidity-Alkalinity:* Whenever alum or sulfate of alumina is used during purification or repurification of swimming pool waters the water at all times when the pool is in use shall show an alkaline reaction.

C. *Clearness:* At all times when the pool is in use the water shall be sufficiently clear to permit a black disk 6 inches in diameter on a white field, when placed on the bottom of the pool at the deepest point, to be clearly visible from the side walks of the pool at all distances up to 10 yards measured from a line drawn across the pool through said disk.

D. *Temperatures:* The water in any swimming pool should not be artificially heated to a temperature above 72° F. The temperature of the air at any artificially heated swimming pool must not be permitted to become more than 8° F. warmer nor more than 2° F. colder than the water in the pool at any time when the pool is in use. For best results it is desirable that air temperatures shall be about 5° F. warmer than the pool temperature.

Bacterial Quality of Waters

A. *Bacteria Count on Agar—2 Days —20° C.* (This count is optional): Not more than 10 per cent of samples covering any considerable period shall contain more than 1000 bacteria per c.c. No single sample shall contain more than 5000 bacteria per c.c.

B. *Bacteria Count on Agar or Litmus Lactose Agar—24 Hours—37° C.:* Not more than 10 per cent of samples covering any considerable period shall contain more than 100 bacteria per c.c. No single sample shall contain more than 200 bacteria per c.c.

C. *B. Coli—Presumptive Test:* Not more than two out of five samples collected on the same day, or not more than three out of any ten consecutive samples collected on different dates shall show a positive test in 10 c.c. of the water at times when the pool is in use.

Cleaning Pool

A. Visible dirt on the bottom of a swimming pool shall not be permitted to remain more than 24 hours.

B. Any visible scum or floating mat-

(*Continued on Page 48*)

With the California Railroad Commission

Denies Miller & Lux Petition

Word has been received from Washington, D. C., to the effect that the Supreme Court of the United States has denied the peition of Miller and Lux, Inc., for an order directing the California Railroad Commission to certify to the court its record in the case in which the Railroad Commission ordered Miller and Lux, Inc., to render public utility water service to its colonists on the Miller and Lux Colony in the neighborhood of Firebaugh, Fresno county, California.

This matter is one in which Miller and Lux, Inc., has appealed to the United States Supreme Court from a decision of the California Supreme Court which sustained the action of the Railroad Commission in fixing rates and requiring proper water service from the domestic system which Miller and Lux, Inc., installed on its Firebaugh colony.

The commission's chief efforts in this matter have been to obtain proper service for the colonists who have purchased lands in this section. It declared in its decision, after hearings by Examiner C. I. Wheat, that Miller and Lux was, in its opinion, operating a public utility water system. Recently, in view of further complaints as to the service, the commission instituted a new investigation into the service being rendered in this section. A hearing was held before Commissioner H. W. Brundige at Fresno, in connection with this investigation.

The matter is still pending, but meanwhile, through the efforts of the commission and its staff, meetings have been held between the officials of Miller and Lux, Inc., and the colonists, as a result of which the matter will probably be settled to the satisfaction of all concerned. Arrangements are to be made for an adequate water service, and the system will be the property of the people who are using the water.

Belvedere Corp. Report

Belvedere Water Corporation operating in Los Angeles County, reports to the California Railroad Commission its 1926 operating revenue at $220,305.40, as compared with $196,-174.46 for 1925. The operating expenses, excluding taxes for 1926, are reported at $140,001.08, and at $124,786.04 for 1925, leaving net operating revenue of $80,296.32 for 1926, and $71,388.42 for 1925. During 1926 taxes charged to operation amounted to $8,490.22, and for 1925 to $5,860.12. Deducting the taxes leaves operating income of $71,806.10 for 1926, and $65,528.30 for 1925. Adding to the operating income, the non-operating income of the company and deducting non-collectible revenue and rents, results in a gross corporate income, (which represents the amount available for interest, amortization of debt discount, other fixed charges, non-operating expenses, dividends and surplus), of $71,543.60 for 1926, and $65,994.28 for 1925.

Ask Rehearing on Transfer

The California Railroad Commission dismissed without prejudice the application of Foothill Ditch Company for authority to transfer its properties to Lindsay-Strathmore Irrigation District. The commission held that it would not be in keeping with public policy, and not to the best interests of present

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consumers of the Foothill Ditch Company, and the public generally, to authorize the transfer of this utility to interests wholly beyond the jurisdiction and control of the commission, when such interests have shown no present unquestioned ability to use the existing system to convey water to the lands within the irrigation district.

Foothill Ditch Company and Lindsay-Strathmore Irrigation District have filed a petition with the commission for a re-hearing of the application.

Fix Date for Fresno Hearing

The City of Fresno, having applied to the California Railroad Commission to fix compensation to be paid California Water Service Company, for the properties of Fresno City Water Corporation, which the city proposes to acquire for a municipal water system, the Railroad Commission has called a hearing at Fresno, before Commissioner Thomas S. Louttit, September 15, 1927, at 10:00 a.m., at which the owners of said properties shall show cause why the Railroad Commission should not proceed to hear the petition by the city, and to fix the compensation to be paid therefor.

Visalia Asks Valuation Be Set

City of Visalia, having applied to the Railroad Commission to fix just compensation to be paid to California Water Service Company and/or C. J. Jackson, for the properties of Visalia City Water Company which the city proposes to acquire by condemnation for a municipal water system, the Railroad Commission has issued an order to show cause why it should not proceed with the valuation of that system. The commission has set the matter for hearing before Commissioner Leon O. Whitsell in the City Hall at Visalia on September 14, 1927, at 10:00 a.m.

Water Co. Says Rates Too Low

Diamond Ridge Water Company, supplying consumers in and around the towns of Diamond Springs and El Dorado, in El Dorado County, has applied to the California Railroad Commission for authority to increase its rates, alleging that the present rates are unremunerative. The utility is now operated by 40 consumers, who took over the system in 1925, in order that service might be maintained. The present rates produced less than 20 per cent of operating expenses and maintenance during 1926, it is set forth.

Will Sell Water System

LeRoy W. Gast has been authorized by the California Railroad Commission to sell the Central Square Water Supply, a public utility water system, near Vernon, Los Angeles County, to Nelson R. Crow for the sum of $8,000, and the latter has been authorized to operate the same. The commission has also authorized Crow to issue a promissory note in part payment thereof in the sum of $2,800, payable at the rate of $100.00 or more per month with interest at the rate of eight per cent per annum.

Will Sell System for $365,527

El Dorado Water Corporation has been granted permission by the Cal. Railroad Commission to sell its properties to El Dorado Irrigation District for the sum of $365,527.63, on condition that the irrigation district upon taking over the properties of the utility will continue to supply water to all existing consumers of the corporation, and that any

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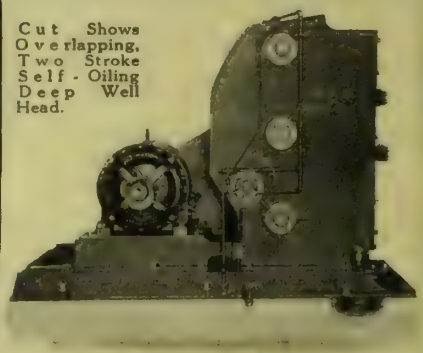

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tolls or charges that may be charged such consumers for service by the district shall be fair and reasonable.

Asks Rate Increase

Liberty Acres Water Company has applied to the California Railroad Commission for authority to increase its rates for the service of domestic and irrigation water in Tracts Nos. 5755 and 6490, Los Angeles County. The company asks the commission also to authorize an emergency surcharge of 50 cents per month on all bills rendered. It is alleged that this charge is necessary to meet immediate expenses in placing the system in fair operating condition.

Will Abandon Water Service

C. E. and H. B. Goodrich have been authorized by the California Railroad Commission to abandon public utility water service to all their consumers in Tract No. 6441, Los Angeles County, on or after May 1, 1927, and have been relieved of all public utility obligations in connection with such system after that date.

Will Issue $100,000 Trust Deed

Ocean Park Heights Water Company has been authorized by the California Railroad Commission to execute a mortgage or deed of trust guaranteeing payment of an issue of $100,000 of six and one-half per cent 20-year bonds, issuance of which was made contingent by the commission upon the filing of an indenture satisfactory to the commission.

Exchange of Land Granted

Spring Valley Water Company has been authorized by the California Railroad Commission to exchange 4.876 acres of land in San Mateo County for an equal amount of land owned by South San Francisco Land and Improvement Company, for the purpose of giving that company a right-of-way to lands which it proposes to develop.

Roseville Co. Will Issue Bonds

Roseville Water Company, having filed a stipulation required by the California Railroad Commission in connection with the authorization of creation of a bonded indebtedness of $200,000, and the issuance and sale of $180,000 of such bonds, the commission has authorized that company to proceed with the issuance of such bonds.

Discontinue Plant Operation

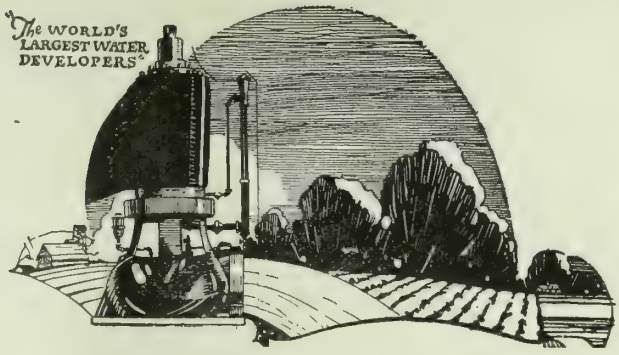
Mrs. Anna H. Moses and Fred A. Moses, operating a domestic water utility in the town of Newark, Alameda County, have applied to the California Railroad Commission for permission to discontinue operation of said water plant.

Ivanhoe Co. Asks for Rules

Ivanhoe Water Company, W. B. March, owner, has applied to the California Railroad Commission for authority to readjust and increase its rates, and to adopt rules and regulations for the conduct of that business.

Long Beach Lays Water Mains

Work has been begun on the installation of mains in Long Beach Boulevard, beginning with the northern Long Beach, California, city limits. A 12-inch main is being laid.



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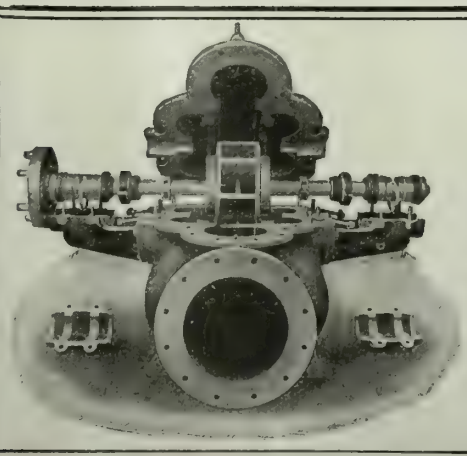

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County Water Works District Act Interpreted

Water District Bonds declared illegal by reason of insufficient publication.

A proceeding is instituted by way of mandamus to require the County Auditor to countersign certain bonds of the Los Angeles County Water Works District No. 9. The respondents claim that the notice of the hearing of the petition and protest was defective.

The Act required that "the Clerk shall also cause a notice . . . to be published at least once a week for two consecutive weeks . . . Said notice must be posted and published . . . at least ten days before the date set for the hearing of the petition."

In holding that the publication made was insufficient, the California Appellate Court in the case of County of Los Angeles vs. Payne, as auditor, 52 Cal. App. Dec. 941 (April 6, 1927) states:

"We find no room for doubt or uncertainty in the requirement that the notice shall be 'published at least once a week for two consecutive weeks,' and that said notice must be published as above provided at least ten days before the date set for the hearing of said petition. Petitioners' claim that the requirement for publication for two consecutive weeks relates to the manner of publication and not to the period of time, cannot be sustained. Aside from this, however, is the equal certainty of the jurisdictional requirement that notice be published at least once a week for two consecutive weeks. We cannot by judicial construction shorten the period of two weeks or fourteen days to eight days, nor can we say that jurisdiction is acquired by any publication short of the requirement. Jurisdiction is not acquired until the publication is complete and inasmuch as it could not be published for two consecutive weeks unless it was published once every seven days for the period of two weeks, it was not complete. The ten-day period must be likened to the time to appear and plead or answer in response to the ordinary processes of court, which does not commence to run until jurisdiction is acquired and in such instances jurisdiction is acquired when the publication is complete. Hence, the requirement that the said notice shall be published at least ten days before the date of the hearing means that after the publication is complete the residents shall have ten days within which to prepare and file their protests to the formation of the district."

Mutual Water Companies Must Record Their By-Laws

Water Stock does not become appurtenant to the land unless the law is complied with.

In the case of Palo Verde Land & Water Company vs. Edwards, et al., 52 Cal. App. Dec. 814, a controversy arose as to whether certain corporation stock sold by a pledgee was appurtenant to the land and not subject to pledge or was personal property and properly subject to pledge. The water company had not adopted By-Laws making the stock appurtenant to the land, and had not recorded its By-Laws as provided by Section 324, Civil Code.

In holding that the stock was subject to sale under pledge, the decision of the Appellate Court states:

"In this action to quiet title to shares of capital stock in a mutual water company purchased by the plaintiff company as pledgee at a pledgee's sale, where it was alleged by defendants that the shares were appurtenant to land owned by them, it was held that the stock was personal property not appurtenant to land and properly the subject of a pledge, where the company has no by-laws recorded in the office of the County Recorder pursuant to Sec. 324 Civil Code, to the effect that the stock was appurtenant to land."

Reclamation Engineer's Pay Not Exempt from Tax

Income based upon percentages construed to make employee an independent contractor.

A ruling of extreme interest to employees of Political subdivisions of a state such as irrigation, drainage, levee and reclamation districts, was rendered by the United States Board of Tax Appeals in the case of Fred H. Tibbetts, Petitioner, vs. Commissioner of Internal Revenue, Docket No. 2479, Promulgated April 14, 1927.

The Petitioner was employed by various political subdivisions or districts of the State of California as engineer. The employment was continuous and the compensation to be the actual cost of all employees of petitioner on the work and 2% of the actual construction cost of all work performed by such district.

In holding that the petitioner was an independent contractor and not an employee the commissioner states:

"The petitioner did not enter generally into the employment of the irrigation and reclamation districts; he was employed only for the purposes specified in his contracts. The contracts contained nothing which reserved to the officials of the district any control or right of control which, as set forth in the quotation from Metcalf & Eddy vs. Mitchell above 'characterizes the relation of employer and employee and differentiates the employee or servant from the independent contractor.'"

In support of his ruling the commissioner quotes from and approves the case of Louisville, etc., vs. Wilson, 138 U. S. 501, reading as follows:

"The term 'officers' and 'employees' both, alike, refer to those in regular and continual service. Within the ordinary acceptation of the terms, one who is engaged to render service in a particular transaction is neither an officer nor an employee. They imply continuity of service, and exclude those employed for a special and single transaction. An attorney of an individual, retained for a single suit, is not his employe. It is true, he was engaged to render services; but his engagement is rather that of a contractor than that of an employee."

Claims Right to Use of Water By Adverse Use

Court holds that no water right is obtained when service is given by a public utility.

The Kellogg Power & Water Co. of Idaho had been engaged for some twenty-five years in supplying the inhabitants of the towns of Wardner and Kellogg with water for domestic purposes, as a public utility. For more than five years prior to the institution of the action, respondent was rendered the service furnished the other users of the system, but had neither been required to nor had made payment therefor. Upon the company threatening to cut off the water supply respondent obtains an injunction claiming a water right by reason of five years adverse use.

On the point of adverse use the Supreme Court of Idaho in the case of Rowland vs. Kellogg Power & Water Co., 253 Pac. 840 (Feb. 19, 1927) states:

"It is not thought necessary either to set forth or enter into a discussion of the evidence on which respondent relies to establish a right based on adverse use, for the reason that we have reached the conclusion that private ownership of water, devoted to the domestic use of the inhabitants of a city, may not be so acquired."

In defining the right of a user receiving water from a public utility the Supreme Court of Idaho adopts the rule of the Supreme Court of California as follows:

"The right of an individual to use the water of a stream devoted to the public use of a city and its inhabitants arises out of the fact that he is a member of the public to the use of which the water is dedicated. Previous use or enjoyment does not affect the

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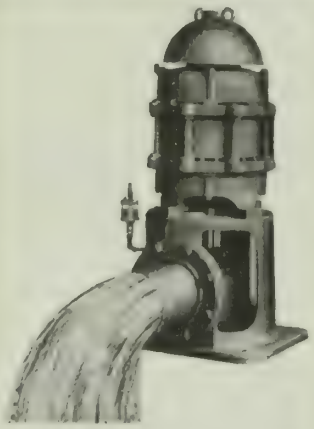

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right. And no one can acquire a greater right than, as a member of that public to which its use is devoted, to demand and receive an adequate supply by complying with reasonable rules and regulations and paying the rate therefor fixed by the state."

All Parties To Be Brought in To Determine Water Claims

Proof of remote grantors' intention as to future water use proper.

In the case of Davis vs. Hunt, 253 Pac. Rep. 394, (Colo. Feb. 7th, 1927) water rights dating back to 1881 became involved in an adjudication of water rights and various judgments rendered from time to time between various claimants were introduced in evidence. In criticizing the introduction of these old judgments the Supreme Court of Colorado states:

"The disputes of the parties and their grantors have led to such a multiplicity of suits, with indications of more, that we hope that they may be terminated in a case where the rights of all interested parties will be protected. All claims must be determined as to date and amount, without the handicap or confusion of the two attempted statutory adjudications."

On the attempt to show the intention of a prior grantor's intention as to the use of the water, the Court says:

"Defendant Mrs. Davis should have been allowed to prove Belle Sanderson's intentions as to the future use of her appropriation. The question of diligence was also relevant."

Annual Assessment by District Is Only Lien Created

Bonds of an irrigation district do not constitute an incumbrance upon a tract of land in the district.

In the case of Clark vs. Demers, 254 Pac. 162, (Mont. Feb. 11, 1927) the question arose as to whether a bond issue of an irrigation district was such a lien or incumbrance as to come under the covenants of a deed against liens and incumbrances.

In holding that it was the annual assessment and not the bond issue that creates the lien, the Supreme Court of Montana states:

"The Bond issue is a general obligation resting upon all the lands within the district —and excluding all other classes of property therein, and therefore, in the broad sense, a lien exists. But in the specific sense of a charge on property for the payment of a debt or duty, and for which it may be sold in discharge of the lien—this general obligation of all of the lands in the district for the payment of the bonds cannot be said to be a lien. The law in no manner provides for, or contemplates, a foreclosure of a lien by the bondholders, but does provide for the enforcement of specific liens upon the several tracts of land for the payment of the annual levies and assessments. In California it is held that a lien exists only to the extent that it may be enforced, and that the method of applying the lien against land in an irrigation district is by the levy of assessments against the property and enforcing the lien which attaches upon the levy being made."

Irrigation District Has Right To Change Its Divisions

The fixing of the size and boundaries of the divisions of an irrigation district is within the discretion of the Board of Directors.

On November 25th, 1924, the Board of Directors of the Imperial Irrigation District passed a certain resolution wherein they changed the boundaries of the divisions of the district under the provisions of Sec. 15d of "the California Irrigation District Act" which provides:

"The Board of Directors when they deem it advisable for the best interests of the district and the convenience of the electors thereof may . . . change the boudaries of the divisions . . . provided, such changes shall be made to keep each division as nearly equal in area and population as may be practicable."

On the following day the directors amended this resolution and interchanged the designations of districts three and four. In upholding the resolutions the Supreme Court of the State of California in the case of McKim, et al., vs. Imperial Irrigation District, et al., ...Cal. Dec..... (April 22, 1927) in a re-hearing of the same case reported in 73 Cal. Dec. p. 418 (March 25th, 1927) states:

"At the outset of the trial, the court recognized the rule that the motive of the directors was immaterial in passing the resolutions in question if they had the power to pass them, and refused to admit testimony regarding the motives of the directors. These rulings were in harmony with the cited cases.

It follows that the findings of the trial court upon the motives and intent of the directors are immaterial and are not sustained by the evidence. They merely repeat the allegations of the complaint concerning these matters and are directed to matters which the trial court expressly excluded from consideration. . . .

This brings us to a consideration of the discretion involved in changing the boundaries. The directors were vested with power to change the boundaries "when they deem it advisable," provided such change shall be made to keep each division as nearly equal in area and population as may be practicable. This grants a very broad discretion and the nature of the district with its varying features is such that no absolute rule for division can be formulated. We think, therefore, that in making the changes in boundaries provided for in the resolution the board of directors was exercising its authority within the discretion accorded to legislative bodies of this character."

Standards for Swimming Pools

(*Continued from Page 42*)

ters on the surface of a pool shall be removed within 24 hours by flushing or other effective means.

BATHING LOAD LIMITS

A. *Frequency of Cleaning Water:* The total number of bathers using a swimming pool during any period of time shall not exceed 20 persons for each 1,000 gallons of clean water added to the

pool during that period. The term "clean water" as used above may be interpreted to mean, new clean water used to refill the pool, new clean water used to replace loss by splashing or during cleaning, water taken from the pool and returned after effective filtration, or any combination of such waters.

B. *Frequency of Disinfection:* The total number of bathers permitted to use a swimming pool during any period of time shall not exceed 7 persons for each 1,000 gallons of water in the pool unless the pool shall have been completely disinfected at least once during that period. The term "completely disinfected" shall be interpreted to mean that the method of disinfection shall be such as to insure a bacterial quality of water as prescribed above.

Operating Control

A. *Trained Operators:* Each swimming pool should be operated under the close supervision of a well trained operator with common sense and good judgment.

B. *Tests for Excess Chlorine:* At any pool where chlorine, hypochlorite of lime or other chlorine compound is used for disinfection, the operator must be supplied with a proper outfit for making the ortho-tolidine test for excess chlorine and with permanent standards showing maximum and minimum permissible chlorine in the water. Tests for excess chlorine in the water must be made every day that the pool is in use.

C. *Tests for Acidity:* At any pool where alum or sulfate of alumina is used or where artificial alkalinity is added to the water the pool operator must be supplied with a proper outfit for testing for acidity and alkalinity and must make such tests on the water every day that the pool is in use.

D. *Operating Records:* Every pool operator must be supplied with a proper notebook or with blank forms on which shall be recorded every day the number of persons using the pool, the volume of new water added, the temperature of the water and the temperature of the air. Wherever a pool is used by both males and females the number of each and whether adults or children should also be recorded. At all pools where artificial circulation, filtration, or any chemical treatment is used, a full daily record must also be kept of the actual time pumps and filters are in operation, of the time each filter is washed or cleaned, of the time and amount of each chemical used or added, of the time the bottom and sides of pool are cleaned, and the results of all acidity, alkalinity, and excess chlorine tests.

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OVERHEAD IRRIGATION

WHAT WILL YOUR PUMPING PLANT COST THIS SEASON?

By J. G. HAMILTON

AS SUMMER approaches many irrigators are contemplating the installation of pumping equipment of one type or another, and many inquiries are arising regarding the respective costs of electric motors and internal combustion engines as prime movers. In general, most of the overhead installations, particularly in the citrus districts, require a pressure which is in excess of the delivered pressure of the irrigation water furnished by the mutual water companies. This can only be obtained by the installation of a booster plant, which will take the water at the delivered pressure and redeliver it into the overhead irrigation system lines at such an increased pressure that economical distribution is obtained throughout the entire system. Often these booster plants are relatively small, as the desired increased pressure is not great.

Costs Enumerated

It is beyond the scope of this summary to give costs of pumping installations in detail so that they will be generally applicable throughout the irrigation districts. In order that the prospective purchaser may have clearly in mind the items which usually enter into the cost of a pumping plant, estimates of the cost of two of the more common types of plants are given. Conditions peculiar to different communities will affect these estimates, and the costs reported should be considered only as approximate.

Consult Reliable Dealers

Before a plant is purchased, quotations on the proposed installation should be obtained from reliable dealers. Most of the larger pump equipment companies operating along the west coast have well-organized engineering forces to assist the purchaser in the solution of his individual problem, and it is their desire that the purchaser request this service.

The United States Bureau of Agriculture has compiled figures on the relative costs of pumping plants and published them in their Farmers Bulletin No. 1404. The purpose of this bulletin is to guide those interested in pumping from wells for irrigation, and making available the most essential information pertaining to well construction and the selection, installation, and operation of pumping plants. The figures given below are taken from this bulletin, a copy of which may be obtained from the Bureau upon request.

It is not the purpose of this data to make a direct comparison between electrically driven pumps, gas engine driven, or oil engine driven equipment, but to call to the attention of the reader some of the most important cost items connected with a pumping plant installation, such as depreciation, interest on the investment, taxes and insurance, and other items which are usually overlooked by the average man in compiling the cost figures of a pump installation.

In each of the two types of motive power described below, the cost of the transmission line has been omitted. The reader should ascertain the cost of bringing electrical current to his farm from the nearest power main, and what refund would be made in case the initial expense were charged to him.

ELECTRICALLY-DRIVEN CENTRIFUGAL PUMP UNIT IN PIT

Conditions:

Crop to be irrigated, alfalfa.

Depth of water required on land, 3 feet in six irrigations, in a 30-day rotation in 6-inch applications.

Amount of water furnished by well, 2 second feet, or 900 gallons per minute, which will irrigate 4 acres 6 inches deep every 12 hours, or 120 acres in thirty 12-hour days, or fifteen 24-hour days.

Lift of water—40 feet.

Theoretical horsepower—9.

Plant Efficiency—60 per cent.

Motor required—15 h.p.

Cost of Plant:

Well 100 feet deep, drilling @ $2.00 per foot	$200.00
Casing, 12-inch double stovepipe, 12-gauge, 60 feet @ $2.25	135.00
Casing starter, 20-foot, 3-ply and ring	90.00
Pit, 8x8 by 25 feet; concrete 6-inch wall	375.00
Pump, single stage horizontal centrifugal, direct connected to 15-h.p. electric motor, complete	900.00
Pumphouse, with concrete floor, etc.	400.00
Total cost of plant	$2100.00
Cost per acre ($2100/120)	17.50

Cost of Operating Per Season:

Interest on $2100.00 @ 7%	$147.00
Taxes and Insurance @ 1%	21.00
Depreciation of machinery (Value $900 @ 10%)	90.00
Depreciation of house and well (Value $1200 @ 5%)	60.00
Power consumed, 11.2 kilowatts for 2160 hours @ 2c	483.84
Repairs, lubricating oil, and attendance, per season	50.00
Total cost of operating per season	$ 851.84
Cost of pumping per acre per season ($851.84/120)	7.10
Cost of pumping per acre foot of water ($7.10/3)	2.37

CASE WHERE THE CENTRIFUGAL PUMP IS DRIVEN BY OIL ENGINE

It is estimated that the plant described above could be installed with a 15-h.p. oil engine, necessary changes being made in pit and house design, at an approximate cost of	$2800.00
Cost per acre for oil engine plant ($2800/120)	23.33

Operating Costs with Oil Engine

Interest on $2800 @ 7%	$196.00
Taxes and Insurance @ 1%	28.00
Depreciation of machinery (Value $1600 @ 10%)	160.00
Depreciation of house, well, and pit @ 5%	60.00
Fuel, 1½ gallons 24-gravity oil per hour for 2160 hours at 5 cents per gallon	162.00
Repairs, attendance, and lubricating oil, season	150.00
Total cost of operation per season	$ 756.00
Cost of pumping per acre per season	6.30
Cost of pumping per acre foot of water	2.10

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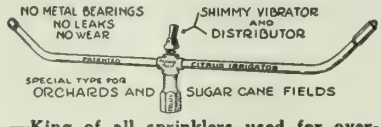

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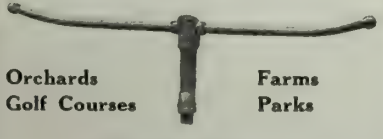

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SURVEY *of* HYDRAULIC DEVELOPMENT

A summary outline of developments contemplated on Western projects which have been announced during the month

Filtration and Chlorination

ELLENSBURG, WASH.—The city plans the installation of a chlorination system in connection with the water supply system coming from Lake Cle Elum.

* * *

LOS ANGELES, CALIF.—The city is about to install a new chlorination plant at the outlet of the new San Fernando Reservoir. Work upon this will start in the very near future. Cost approximately $30,000.00.

* * *

KELSO, WASH.—Superintendent A. L. Minnard is advocating the construction of a filtration and purification plant, to be used in connection with the water supply from the Cowlitz River. This will make the present supply available for domestic use.

* * *

ANACORTES, WASH.—The bond election carried by a large majority. This will allow the installation of two 500-gallon filter units, and a new ten-inch pipe line, and an 8-inch line. There will also be 4 fire hydrants, a booster pump at Heart Lake, and another at Deutsch's Ravine.

* * *

BEVERLY HILLS, CAL.—Trustees of the city have ordered the installation of a filtration plant, to be located near Lacienga Boulevard. The cost is estimated at $220,000. In addition to the filtration plant there will be a 5,000,000-gallon reservoir, built on adjoining property. Work will start as soon as possible, and the plant is expected to be in operation about next November.

Irrigation Development

PHOENIX, ARIZ.—The $500,000 bond issue of the Roosevelt Water Conservation District has been sold to the B. J. Van Ingren Co. of New York.

* * *

CHANDLER, ARIZ.—The Roosevelt Water Conservation District has voted to issue $500,000 in bonds, the proceeds of which are to be used in cement lining all of the canals throughout the three districts. The vote was passed by a 7 to 1 majority.

* * *

AZUSA, CAL.—The Azusa Irrigating Company has voted a $200,000 bond issue, the money to be used for the establishment of a modern domestic water supply, and irrigation water for 4000 acres of land adjoining this city on east and south. According to reports there will be laid 30 miles of mains and laterals ranging in size from 20-inch to 4-inch.

MEDFORD, ORE.—Local business men subscribed to $50,000 worth of bonds for repairing the lower section of the Medford irrigation canal. This will allow the lining of the canal with gunnite so as to prevent leakage. The Talent Irrigation District has voted to spend $35,000 for improvements, which will include a steel syphon 6500 feet long across Bear Creek near Billings Hill, and also construct five miles of canal from this syphon to Wagner Creek.

Pumping Equipment

THE DALLES, ORE.—The Oregon Fruit Company, Inc., is starting the drilling of a well to irrigate the Dufur orchard tract. Deep well turbines will be used. John Enders, manager of the company, is in charge.

* * *

CORVALLIS, ORE.—Farmers in this region are installing small pumping plants for their individual operations. The usual plant consists of a 15-h.p. engine coupled to a six-inch pump.

* * *

MARCH FIELD, RIVERSIDE, CALIF.—Three wells are now being drilled as a source of additional water supply. Contract for the first has already been let, and May 10 is the date set for the other two contracts to be awarded. The contract for the pumping equipment has not yet been considered.

* * *

LAKESIDE, CALIF.—Plans have been formulated for the town to have a water system of its own. The supply is from the San Diego River and the directors of the local irrigation district have already begun the installation of the necessary plant. The well has been drilled and the pump installed. The water will be pumped into a sump, and taken from there by a booster pump through a 16-inch line to a 200,000-gallon tank. The booster pump capacity is to be 200 gallons per minute. The booster plant is yet to be built and bids will be taken soon.

Reclamation and Drainage

TUCSON, ARIZ.—Election will be held May 9 to vote on a $173,000 bond issue for constructing a flood control system.

* * *

ONTARIO, ORE.—Tertling & Sons of Moscow, Idaho, submitted the low bid for the first six units of the work on the Oregon Vale project. Their bid was $149,440.50. This is one of the portions of the work to be done in this neighborhood, the total estimate of the project being approximately $3,500,000.

CALEXICO, CAL.—W. I. Bassett is the engineer in charge of the work on the 15-mile emergency levee in the Volcano Lake district. It is contemplated that it will require about 40 days for completion.

* * *

BAKERSFIELD, CALIF.—Petitions are in circulation for formation of the Kern River Levee District. Civic Commercial Assn., H. I. Tupman, chairman of the committee in charge, is back of the project.

* * *

INGLEWOOD, CALIF.—According to a recent announcement, City Engineer Willis S. Peffer, L. W. Armstrong, Los Angeles, storm drain engineer, and A. B. Arnold of the county engineering forces, have jointly decided that the proposed North Inglewood storm drain project should be handled as one job and the cost spread over one assessment district. The drainage district comprises 2148 acres.

* * *

BAKERSFIELD, CALIF.—Dr. Morris Mosquito Abatement District, care Bakersfield Service Centre offices, has decided by vote of directors to deepen the channel of the Kern River to reclaim considerable areas of low swampy lands. Work proposed includes installation of dredger, 1000 ft. of discharge pipe, teams, etc.; estimated cost, $42,000, of which $24,000 will be expended on the dredging.

Reservoirs and Dams

GIRARD, CAL.—The city is building a 41-acre-foot reservoir on the outskirts of the town. This additional supply will be connected with the present supply lines.

* * *

KIRKLAND, WASH.—A reservoir will be built by the city costing about $27,000 according to advice received here recently. A new 3½-mile pipe line will feed into the reservoir.

* * *

ST. JOHNS, ARIZ.—Anderson Bros., El Paso, Texas, are reported to have the contract to build the Black Canyon Dam in Apache county, about 10 miles north of Kouck. The dam is expected to provide for 8000 acres of Pucco River valley land.

* * *

WALLA WALLA, WASH.—The city has voted a $150,000 bond issue for the purpose of constructing a hydro-electric plant, and additions to the present city water supply system. In connection with this work there will be constructed several conduits of large size, and comparatively long length.

* * *

OAKDALE, CALIF.—Sierra & San Francisco Power Company have filed application for a permit to construct a dam at Beardsley Flat on the middle fork of the Stanislaus River. It will have a capacity of 35,000 acre feet, and the estimated cost is $3,500,000.

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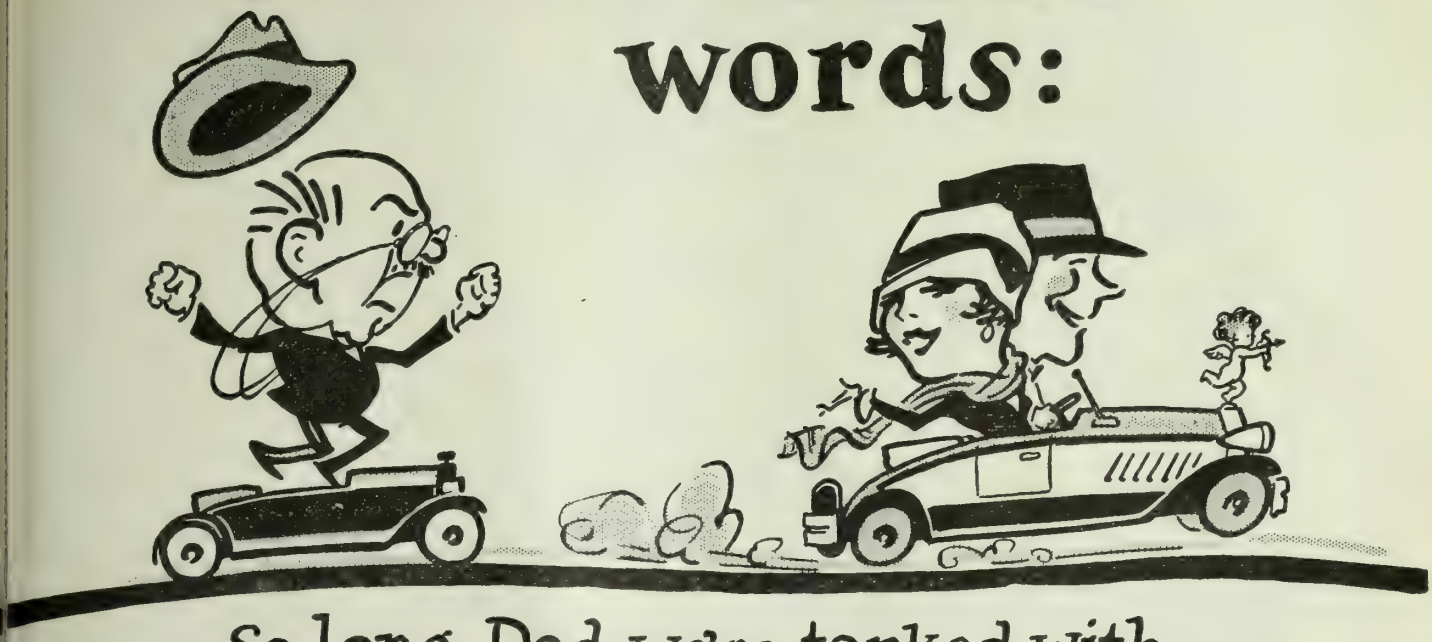

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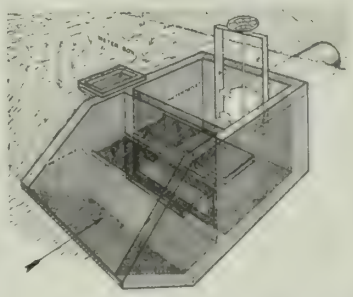

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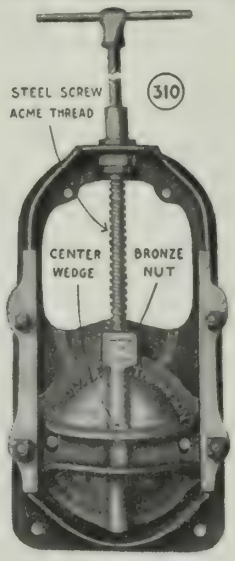

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LOS ANGELES, CALIF. (San Gabriel Canyon Dam).—Supervisor Graves has announced that plans and specifications for the San Gabriel Canyon Dam will be ready May 5 and that an order authorizing call for bids will be made at that time, bids probably to be in July 5.

* * *

ESCONDIDO, CALIF.—Escondido Cement Products Co. has the contract and has started work on a concrete dam on Four-Ess Ranch, the property of Albert E. Smith, motion picture director, located about 4 miles southwest of Lake Hodges bridge. The dam will be 20 feet high and 80 feet in length

* * *

CHEHALIS, WASH.—The city council has decided to build a five million gallon reservoir on the hill top near the St. Helens Hospital. The estimated cost is $75,000. Bids for this work will be called at an early date. The work is under the direction of City Engineer Bantz.

* * *

EL CENTRO, CAL.—Imperial Valley Irrigation District is progressing with its hydro-electric development. Dams are planned to develop 3150 horsepower. The Rosita dam, 45-foot head; the Alamo dam, 13.5-foot head; and the Number Eight Heading, 12-foot head. M. J. Dowd, district engineer, is in charge of this work.

* * *

WALNUT CREEK, CAL.—Engineer A. Naas of Antioch, Cal., is concluding survey of the water situation in Walnut Creek. It is contemplated to hold a bond election for $70,000 to provide additional water supply for the community, besides adding to the present distribution system. One of the plans suggested is the erection of a dam on Walnut Creek to accommodate 50,000,000 gallons.

* * *

SACRAMENTO, CALIF.—The H. M. Byllesby Company has applied to the division of water rights in seven different applications for the right to appropriate water from the Feather River. These locations are at Bidwell Bar, Bean Creek, Crooked Bar, Sherman Bar, and others. The plants will be capable of developing 150,000 kilowatts, electrical energy. The reservoirs which will be built will have a capacity of nearly 240,000 acre feet, and the lakes formed will be known as Gold Lake, Grizzly Creek and Clio reservoirs.

Sewage Disposal

LEMOORE, CALIF.—C. C. Kennedy of Berkeley has been engaged to design the proposed city sewage disposal plant.

* * *

SAN LUIS OBISPO, CALIF.—$25,000 sewage disposal bond issue carried at recent election. Warren B. Burch, civil engineer, prepared the sewer survey for the council.

* * *

LIVINGSTON, CALIF. — Meeting was held by trustees April 15 to decide on question of the proposed $85,000 sewer and water bond issue. John F. Bates, city engineer.

* * *

LOS ANGELES, CALIF.—County Sanitation District No. 2 has ordered the construction of a temporary disposal plant and for the main trunk sewer to handle congested territory in both districts Nos. 1 and 2. Plans and specifications are being prepared by A. K. Warren, chief engineer, 202 Law Bldg., 139 N. Broadway.

MAYWOOD, CALIF.—Estimated cost of proposed lateral sewer system, involving 60,000 feet of house connections and 15 miles of lateral lines, is $150,000, according to City Engineer George A. Schwabland.

* * *

KIRKLAND, WASH.—The city council are discussing plans for the establishment of a new sewage disposal system. At the present time no definite move has been made, but it appears that this matter will come to a head within a short time.

* * *

TUCSON, ARIZ.—$120,000 bond issue for extensions to sewer system and $100,000 bond issue for sewage disposal system will be voted on at special election in May. Black & Veatch, Ferguson Bldg., Los Angeles, engineers, on the work.

* * *

MONTECITO, CALIF.—Application has been made by the Santa Barbara Biltmore Corp. for permission to construct a sewer outfall in front of its property at Montecito, to extend into the Pacific Ocean a distance of about 1050 feet from mean high tide line. Maps showing location of the proposed work will be on exhibition in the office of the U. S. Engineer, 725 Central Bldg., Los Angeles, until 11 a. m., Friday, April 22, 1927. Maj. H. A. Finch, dist. engineer.

* * *

CALCUTTA, INDIA.—The Department of Commerce of the United States has received inquiries from Vice Consul Robert L. Buell, Calcutta, relative to the new sewage system for that city. This project is of special interest because of the extensive nature of the work involved and the possibilities offered for the sale of American machinery and equipment. It is estimated that the construction of the new sewage system will require from 5 to 10 years for completion and will cost approximately $12,500,000 at the present rate of exchange. All work will be done under private contract. The equipment to be purchased includes machinery for the new pumping plant, operated by steam, and capable of lifting 300,000,000 gallons daily to a height of about 20 feet. Interested parties may obtain further information by addressing the Department of Commerce referring to India No. 238619.

Waterworks

TUCSON, ARIZ.—Election will be held May 9 to vote on a $250,000 waterworks bond issue.

* * *

SAN LUIS OBISPO, CALIF.—Bond issue for purchase of the Laguna property for a water supply carried at recent election.

* * *

MANTECA, CALIF.—Plans are under way on the preliminary work necessary to call a bond election for a new waterworks system.

* * *

SANTA BARBARA, CALIF.—All bids for installing water mains under contracts 343, 344, 345 and 346, received April 12 rejected by city April 14. New bids will be asked.

* * *

CENTRALIA, WASH.—A committee has been appointed to pass upon the proposed plans for a new $150,000 water distribution system. Dr. E. C. Roberts is chairman, and will make a report to the city commissioners.

For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

HOQUIAM, WASH.—The local water company has been sold to the Federal Water Service Corporation of New York City. The new owner contemplates many new extensions and improvements.

• • •

WILLIAMS, CALIF.—A bond issue has been voted by the city amounting to $38,000 for the purpose of providing a new municipal water system. The old system has been condemned by the State Board of Health.

• • •

SANTA MARIA, CALIF.—A special bond election will be held shortly in order to vote money for the development of additional water supply. This supply will probably come from wells to be drilled just outside of the city.

• • •

OAK HARBOR, WASH.—City is holding a special election to vote upon a $11,000 bond issue for an additional water supply system.

• • •

MARTINEZ, CALIF.—A new distribution system will be installed in the Mt. View section, work upon which will start immediately. This will supply both domestic water and additional fire supply to the section.

• • •

REDWOOD CITY, CAL.—The Ravenswood water district has been formed and a bond issue of $30,000 voted for improvements. This money will be spent for pipe lines, work upon which will be started within a few months.

• • •

ABERDEEN, WASH.—The city is holding a $1,600,000 bond election for the purpose of building an industrial water system on the Lower Wynooche River. This has been described in a previous issue of MODERN IRRIGATION.

• • •

RAMONA, CALIF.—The local irrigation district has awarded the contract for the installation of the new distribution system upon which bids were called for recently. The work was awarded to R. F. Ware, contractor of Los Angeles.

• • •

EVERETT, WASH.—Council authorizes purchase of $12,000 worth of 12-inch steel pipe for city mains. Superintendent Klapp proposes to re-lay four blocks of pipe on Broadway to conform to the new grade. The amount of 12-inch pipe needed will be about 3000 feet.

• • •

SHAFTER, CALIF.—Shafter voters have approved the new water system project, which has been under discussion for some time. $30,000 has been appropriated for the installation of several new lines, which will feed the farming district. A water tower, together with another deep well pump will be installed shortly.

• • •

BELLINGHAM, WASH.—Water Superintendent McMillan was instructed by city council to install 6-inch main along Victor street, from Connecticut to Northwest. Plans are also under way for a new distribution system that will accommodate a population of 10,000 people.

• • •

CARTAGENA, COLOMBIA.—Bids are being solicited for material to be used in the construction of the new waterworks for the city of Cartagena. The Colombian Congress has voted an appropriation of $1,500,000 for this new work. The most important item to be used in this work is pipe of all sizes and types. Refer to Department of Commerce, Colombia No. 239690.

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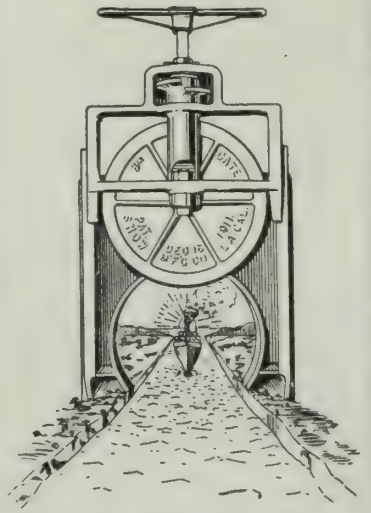

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POMONA, CAL.—The city will replace a number of old supply lines of small size with 6 and 8-inch cast iron pipe. These lines will be installed this spring and summer. The new line on Gibbs street will be six-inch cast iron, according to City Engineer F. C. Froehde, who is in charge of the work.

* * *

HOQUIAM, WASH.—Application has been filed with R. K. Tiffany, hydraulic supervisor, by the city of Hoquiam, to appropriate 50 second feet from the East Hoquiam River. This water will be used to provide an additional supply for the city. Expenditures in excess of $285,000 are contemplated at the present time. Work will start in the fall.

* * *

PORT TOWNSEND, WASH.—City Engineer Sadler asked for authorization to complete 600 feet of 10-inch pipe line leading from Trapper Creek to the main flow line. A new 8-inch line along Monroe street has also been asked for, as well as replacement of a 10-inch line, either cast iron or wood, along Water street. The city will also spend considerable money in repairing the present reservoir.

* * *

TACOMA, WASH.—Plans for the absorption of the Ruston water system are being considered by water department officials. The district was formerly served by the Tacoma Water Supply Company which was acquired by the water department about a year ago. In order to effect this change it will be necessary for the city of Ruston to spend about $20,000 on improvements of its present system.

* * *

MONROVIA, CAL.—City Engineer Gierlich has rendered a report to city council stating that a $250,000 bond issue is necessary to provide for increased pipe line and water supply for the city during the next two years. The projected improvements include several 20-inch mains, replacement of the mountain pipe line, increasing the capacity of the Ivy reservoir and the installation of a booster pump at that location.

* * *

BELLINGHAM, WASH. — Considerable amount of waterworks improvements are contemplated by the city. Present plans call for the installation of a new 16-inch line along the main section of the city; three new Venturi meters on the main lines; establish a metering station on Skookum Creek; enlarge the present reservoir on Sehome Hill; supply water to the Silver Beach district; and move the intake now at Lake Padden to a new location, building new intake and well house.

* * *

TACOMA, WASH.—City council has passed ordinance for the development of a new tract of land approximating 2,500 acres. This will be serviced by both water and sewage lines. The water mains will be 16 and 22-inch, extending from Hudson street to Titlow Beach. The council also passed ordinances for preliminary work on the Lake Kapowsin and Puyallup River water supply project, and for smaller amounts of money to be expended upon improvements to existing lines.

* * *

OGDEN, UTAH.—According to John C. Brown, the city is in dire need of conserving its water supplies, and the first measure taken is to install meters upon all services. It is estimated that there will be approximately 1000 meters installed, and within a short time the entire city will be metered. Mr. Brown believes that the city water problems will be solved temporarily by the installation of these meters, but that additional supplies will be needed within a few years.

* * *

VENICE, CAL.—There are plans afoot to install a new and up-to-date water system for Venice, Mar Vista, and Palms. These plans are sponsored by a committee from the city chamber of commerce. It is contemplated that the supply will come from the Los Angeles municipal water supply, and the committee is working toward this end. President C. W. Hooper of the Palms Chamber of Commerce, and Tommy Ryan of Venice were chosen to act for the committee. It is contemplated that Barnes City will also be included in the general plan.

Conference Tackles Problem

(*Continued from Page 14*)

planting of new lands for specialty crops in California.

Financing the District

Tom Lambert, president of the Los Angeles County Farm Bureau, presided over the morning session, April 26th. The first speaker was Will C. Wood, State Superintendent of Banks, who gave a very interesting discourse on "The Requirements for Sound Irrigation District Bonds." Irrigation district bonds are certified by the State Bond Certification Commission of which the State Superintendent of Banks, State Attorney-General and State Engineer are members, the first considering the economic feasibility of the project; the second the legal and the third the engineering possibilities. Mr. Wood stated that two-thirds of the bond issues which have been defaulted in payment in California were agricultural and that this was one of the important reasons for the high cost of agricultural project financing. He suggested that there should be a constitutional amendment to secure genuine adjudication of water rights, that is, to set at rest present objections to the appropriation of water and its best use. The recent Herminghaus decision in the San Joaquin Valley was declared to have militated against irrigation development in California. His second suggestion was that there should be better investigation of the economic feasibility of irrigation projects and that a thorough study of all factors which make for the agricultural success of the projects be carefully made. The third and final suggestion was to the effect that the Bond Certification Commission should be given authoritative powers to see that irrigation districts remain economically feasible throughout the life of the bonds.

Mr. Wood further declared that in many cases, projects are sound from all angles at the time the bonds are certified, but because of many elements, chiefly promotional, they become unsound before the bonds are paid off. The elimination of this, and other factors of uncertainty, he declared, will ultimately

result in a higher percentage of success in irrigation projects and finally work toward the lowering of financing costs of such construction.

C. J. Thorson, treasurer of the California Bank of Los Angeles, read a paper on the determination of price and interest rate on irrigation district bonds. He analyzed this subject from two well defined points, first, the facts establishing the intrinsic and potential security of the bonds, and second, conditions affecting market ability of the bonds after the fundamental security of these bonds has been satisfied.

Colonization Requirements

Discussion of a paper by Stephen Barneson, which had as its title "The Elements Considered in Approving Land Colonization Projects," was by Dr. George P. Clements, manager of the Agricultural Department of the Los Angeles Chamber of Commerce. Dr. Clements gave the elements necessary for successful land colonization projects as follows: quality, topography and durability of soil; cost and permanency of water supply; climate—seasonal daily temperature range, humidity and winds; transportation and market facilities; cost of lands; size of parcel, and the social, educational and religious offerings. He declared that blanket approval of real estate projects is dangerous.

Dr. Clements also declared that while the above elements are of first importance, the selling prospectus or the salesman's offer should also be considered. It should not, he declared, be in any way permitted to violate substantial facts. On the contrary it should be confined to general averages, both in quality of production and market value. Maximum for yields of other districts should not be permitted to be applied to the selling of land in another.

The afternoon session of the last day's meeting had largely to do with the discussion of economic problems to be considered in determining project feasibility which was covered by W. W. McLaughlin, Chief, Division of Irrigation Investigations, U. S. Department of Agriculture, Prof. Chas. F. Shaw, Division of Soils Technology, University of California, and F. B. Headley, Chief, Department of Farm Development, University of Nevada. "A Sound Policy for Future Irrigation Development" was the subject covered by W. S. Rosecrans, vice-president, California Farm Bureau Federation. W. D. Ellis, president of the Federal Land Bank, Berkeley, presided in this discussion and summarized the afternoon session which chiefly covered points discussed throughout the conference.

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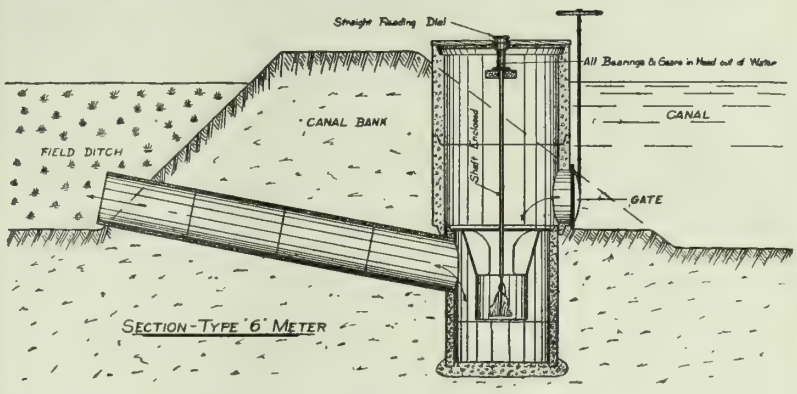

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Progress in Water Purification

(*Continued from Page 31*)

same thing but goes a little farther. In the early days, it was considered that all that was necessary was to take out the bacteria and turbidity. Then color removal also began to be demanded. Then the demand came to destroy what bacteria we could not eliminate and sterilization became effective. Then the hardness was objectionable and it had to be removed. All these were demands for elimination of objectionable compounds or properties from the natural water.

Iodine and Goiter

Did the demands stop here? Certainly not. Some one got the idea that goitre could be prevented by a constant use of iodine, so the entire water supply was dosed with iodine and everybody was compelled to take their iodine, willy nilly, or become dessicated, in order that those suffering from goitre might also be compelled to take their iodine and have their goitrous condition benefited—*maybe*.

Then there were other demands along synthetical lines, which upon the face of them appeared almost as inconsistent as imagination could picture but which were really quite the opposite. Some cities were suffering from water supplies which did not possess enough carbonic acid, while the water of other cities had too much. The demand from those having too little was that additional carbonic acid be supplied to the water in such cities so as to stop the evils of incrustation from which they were suffering. This required the addition of carbonic acid or carbon dioxide to overcome the trouble caused by caustic lime. The demands from the other cities were for the introduction of caustic lime into their water supply to cure the troubles caused by carbon dioxide or carbonic acid.

It would appear therefore that more and more complicated chemical treatments may be expected in the future and that the engineering problems will become more and more complex, requiring more and more equipment, of better and better design, with the probability that some radical departures from present practice may reasonably be anticipated in the not far distant future.

Water Now in Klamath Canal

With the completion of the relining job on the main canal south of Klamath Falls, Oregon, the first water for irrigation on the Klamath project was turned into the big ditch on April 25.

WHO'S *WHO* AND WHO'S *WHERE*

IN THE WORLD OF HYDRAULICS

Personal Notes and Impersonal Observations About Men You Know

E. B. Darlington, superintendent of Minidoka project, and B. E. Stoutmyer, district counsel, made a recent visit to the Boise project.

Hugh L. Crawford, assistant engineer on the Minidoka project, has resigned and has been appointed manager of the Burley irrigation district, Idaho.

W. W. Johnston, associate reclamation economist, spent several days during March on the Yakima project, Washington, going over the land of the proposed Yakima extension.

Ora McDermith, formerly consulting engineer on the Kittitas irrigation project, Washington, is now located in San Francisco as president of the Derbon Construction Co. Mr. McDermith will continue as consultant for the U. S. Bureau of Reclamation.

Edgar Orton, who has been superintendent of the Ventura water department since its purchase from the Southern Edison Company four years ago, has resigned and has recommended that Myles A. Robinson, now assistant water superintendent, be appointed to succeed him.

Major Richard T. Coiner, who has been in charge of river and harbor works in the Portland, Oregon, district, U. S. Engineering Department, has been assigned to the office of the Chief of Engineers at Washington, D. C., where his work will deal with flood control, river improvement, and power surveys.

A. J. Sheldon, consulting metallurgist for the American Rolling Mill Co., of Middletown, Ohio, recently visited the Uncompahgre project, Colorado, where he made an inspection of the High Mesa ingot iron siphon and the riveted pipe siphon across Dry Creek. He is making a microscopic examination of samples taken from these installations.

William Mulholland, chief engineer of the bureau of water and supplies, Los Angeles, with Assistant Chief Engineer Van Norman, left during the early part of May to join Dr. Elwood Mead in Oregon, where they attended the opening of the new McKay rock fill dam on May 10. The engineers of the Los Angeles bureau are making a general survey of all the prominent rock fill dams that have been built recently with the idea of possible utilization of this type of construction in the Boulder Canyon dam.

David C. Henny, of Portland, Oregon, has accepted appointment as a member of the consulting board of engineers for the Los Angeles flood control district. Mr. Henny is a native of Holland but came to the United States in 1884. Since that time he has played an active part in irrigation engineering in the western states. He designed the Henny Venturi weir, introduced new features in earth dam construction and has been connected with the construction of many of the more important dams of the U. S. Reclamation Service.

N. Bursh, for several years manager of the Orland reclamation project in California, has been selected by the interior department, says a recent report from Reno, Nevada, to conduct the studies and investigations for the government upon the headwaters of the Truckee and Carson rivers, for the purpose of determining the best methods of future storage upon the two streams. The last congress made a special appropriation for such an investigation upon the drainage area of the Truckee, and the cost of the work upon the Carson will be met from the investigation fund of the service.

Water will be pumped from the Riverview wells in the San Diego River by June 1, according to a recent report to the city council of San Diego by City Manager Rhodes. The laying of pipe on the new El Capitan line has been completed and all that remains to be done is to put the finishing touches on the job. The Riverview wells were filled up with sand during the flood but the manager has a force of men at work clearing them out. Pumping in the river bottom will enable the water department to meet the peak demand in the warm summer months, says Mr. Rhodes. The pipe line in from the Otay reservoir would not carry the increased load and without the pumps there might be a little shortage, despite the fact that the reservoirs are full.

Annual Hydraulic Dam Number

MODERN Irrigation

The Magazine of Applied Hydraulics

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Vol. III **JUNE, 1927** **No. 6**

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New Work Contemplated and Jobs Under Way

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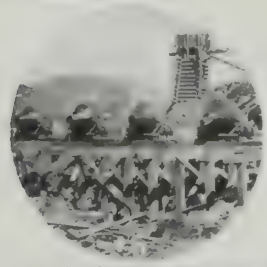
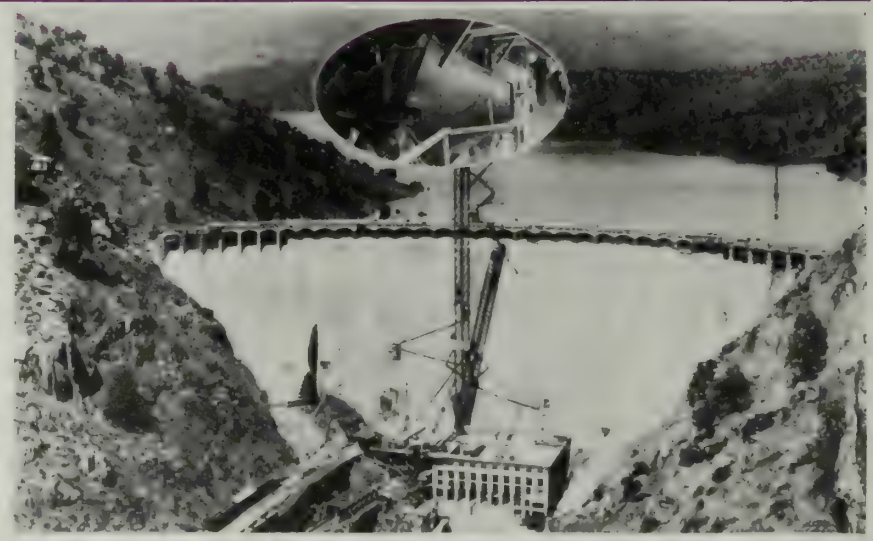


These 28-S Smith Tilting Mixers built the Lake Spaulding Dam of the Pacific Gas & Electric Co. in 1912-13. Two of same group built the Mt. Shasta Dam—shown at the right—in 1925.



Three Smith 56-S Tilting Mixers used in construction of Exchequer Dam, California—Bent Bros., Inc., Contractors. The same mixers (without overhauling) poured the Shaver Lake Dam Construction of the Southern California Edison Co.

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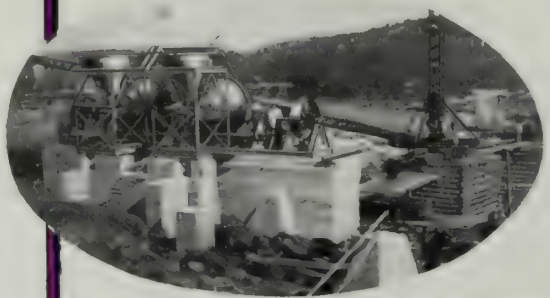

Saguenay River Power Dam at Isle Maligne, Quebec—Quebec Development Co., builders. Two 112-S (four yard) Smith Tilters were used. The Smith 112-S is TWICE AS LARGE as any other mixer built.

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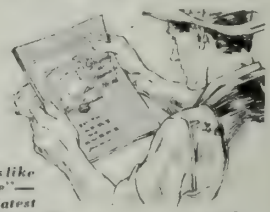

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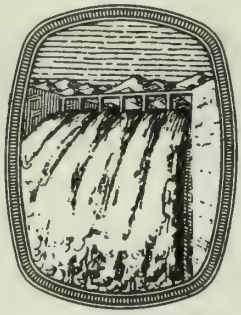
IN THE FIELD OF DAM CONSTRUCTION A NUMBER OF WESTERN ENGINEERS HAVE ATTAINED POSITIONS OF PROMINENCE. ABOVE ARE PHOTOGRAPHS OF A FEW OF THESE LEADING AUTHORITIES, PARTICULARLY THOSE WHO HAVE BEEN IDENTIFIED WITH MAJOR PROJECTS IN THE LAST FEW YEARS (1) FRED A. NOETZLI; (2) D. C. HENNY; (3) CHARLES D. MARX; (4) LOUIS C. HILL; (5) A. J. WILEY.

MODERN Irrigation
The Magazine of Applied Hydraulics



Volume III JUNE, 1927 Number 6

The Hydraulic Dam Number

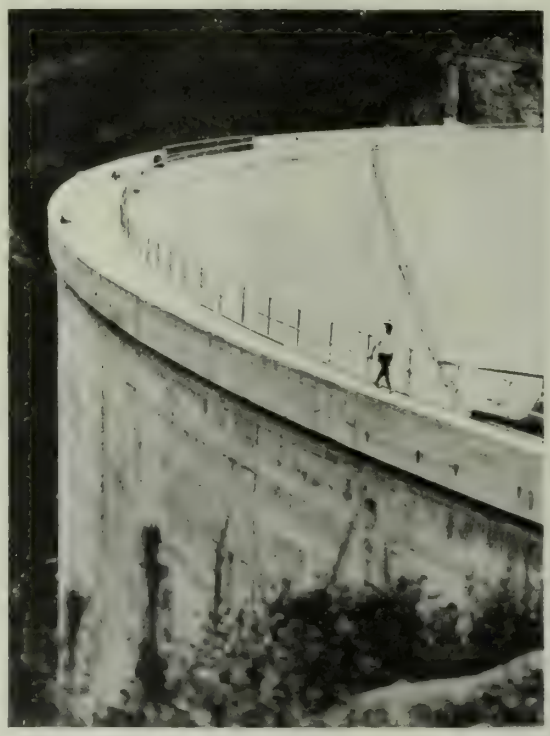
IN DEVOTING this issue of MODERN IRRIGATION to hydraulic dams the publishers do so with the feeling that any pioneer effort such as this must, of necessity, fail to do full justice to so big a subject. Since MODERN IRRIGATION is the only journal in the world devoted exclusively to this department of hydraulics it is, however, the logical medium to undertake such a proposition. And the editors have shouldered their responsibility with the feeling that they have broken the ice; that while, in the making of the issue, they may possibly have fallen short of their ideal, as one usually does who hitches his wagon to a star, they can at least dedicate their efforts to the making of each succeeding hydraulic dam number (it is to be an annual feature) a closer approach to that ideal.

Never before, we believe, has it been brought home—as it is in the ensuing pages—to the engineering profession, and others interested in reclamation and irrigation, the staggering sum invested in hydraulic dams and auxiliary works. The table of dams alone, prosaic at it may appear in print to the casual reader, presents an amazing picture of the development in water conservation and utilization that has taken place in this country and throughout the world. Hundreds of millions have been spent and equally large sums are to be spent in the years to come on works already projected as well as on other projects that must come as the West continues to develop. The appropriation of $25,000,000 for the building of the great San Gabriel dam of Los Angeles County affords, in itself, some conception of the hugeness of the undertakings that are a part of the present era of dam construction; and the estimate of two hundred millions as the amount required to build the Boulder Canyon Dam and auxiliary works on the Colorado River will serve to paint an outline of other great undertakings to come.

As to the magnitude of the field and the market for construction equipment of all types, more need hardly be said. There is, obviously, a great need for a complete compendium of information on the subject of dams and dam construction, especially since nothing of this exact description has ever appeared in print; and it is this need that the editors of the journal have attempted to meet in the annual hydraulic dam number—the

first and only issue of its kind to be produced.

To get the proper perspective on the present state of dam development, particularly its engineering phases, one need not go back very far into dam history, as the great advance in scientific construction easily comes within the memory of most of us. Actually, the building of dams goes back prior to the beginning of modern civilization. Thousands of years ago beside the Nile, the Euphrates and the Yellow River of China the primitive hydraulic engineer planned and constructed his dams and his simple water wheels to utilize the energy of the river current and to irrigate arid lands along the shores. The influence of the regulated use of water resources on civilization, especially in semi-arid lands, can hardly be estimated. Stories of the gardens of Damascus go back of history. Cyrus turned the course of the river Euphrates away from Babylon, and an empire fell and another rose. In the days of Joseph the floods of the Nile were regulated by Lake Moeris, and its operation is credited by some antiquarians with the seven fat and the seven lean years of Egyptian history.

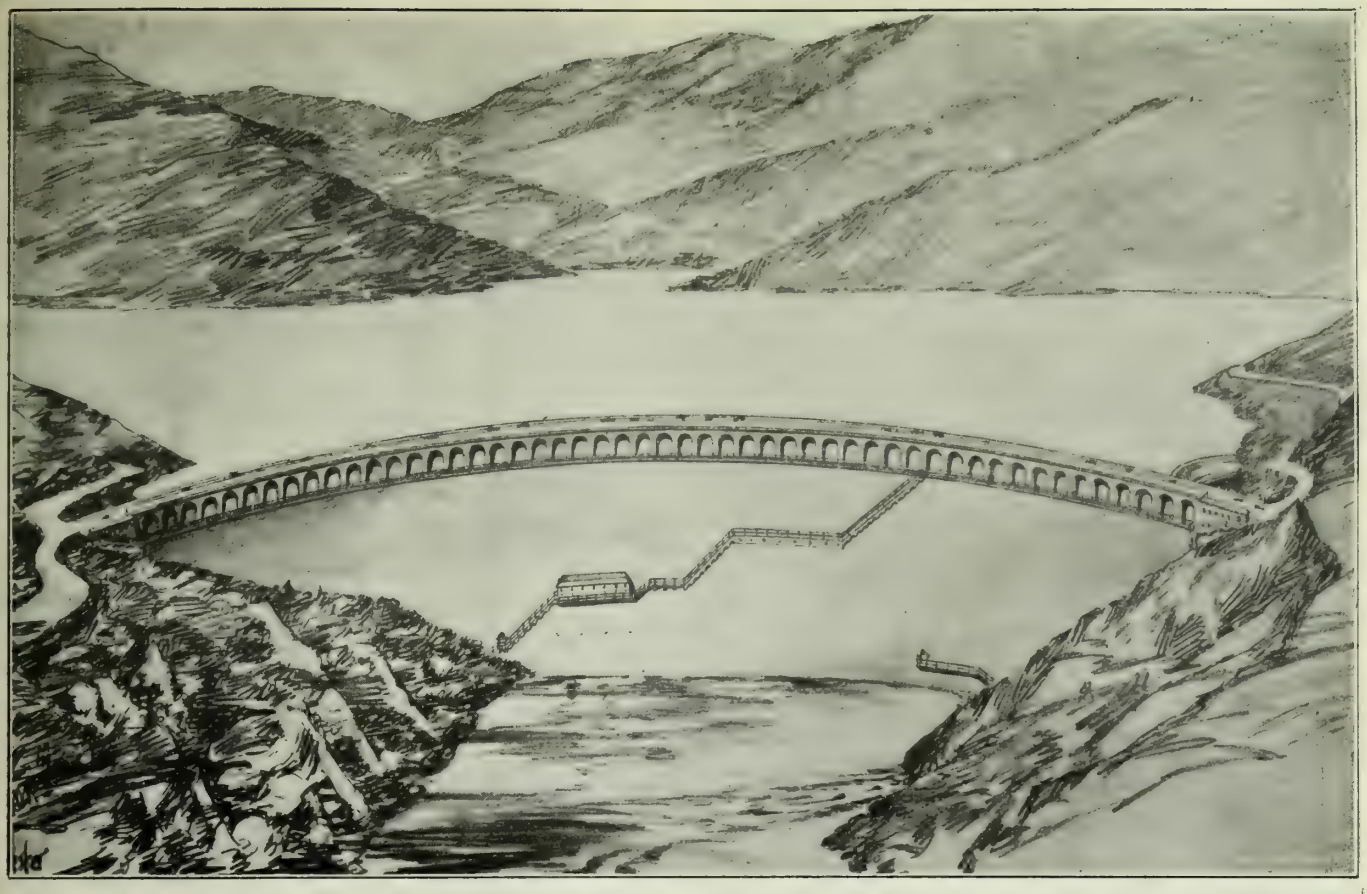


The Sawpit Dam, Los Angeles Flood Control project in Sawpit Canyon, was completed in June. Its crest is 162 feet above stream bed.

From Persia, Assyria and Egypt in the days of Cyrus and Joseph to the Pacific slope of the United States in the twentieth century is a far cry, but the question of water supply is still important—far more so, indeed, because not only do growing cities and agricultural districts need water supplies, but ever increasing industries are developed with water power, and the electric generator and distant transmission of power have been developed. In the semi-arid sections of the western United States, the storage of water for irrigation and power purposes, as well as for municipal uses, has been a highly necessary factor in the upbuilding of this part of the country. Since so great a portion of all the waters reach the ocean within a short time of their precipitation as rain or snow upon the mountain areas, the full development of the water resources of the western states can be attained only through the construction of dams and the release of the impounded waters for use at the needed time and place.

In the West the need for irrigation led to the building of great dams by the Reclamation Service of the Department of the Interior. These dams were constructed, operated and controlled by the Government until the time when the land owners could make full payment for the cost of the works. In like manner, irrigation districts were formed and built dams and constructed irrigation systems without government aid. The soil, barren and sandy before the construction of these dams, grew rich and fertile. Because of the Roosevelt Dam in Arizona, in one of the richest sections of the West, crops can be harvested all the year round. These aggregate annually about $30,000,000.

In conclusion, tribute must be paid to the man who has made possible this prosperity of the West—the engineer. He is the key man in the forward march of irrigation. The others have their indispensable roles to play—the financier, who accumulates the surplus of many investors and makes them available for the construction of large works, in turn to create new wealth; the executives, who bring to the direction of irrigation activities the results of their years of experience with problems of business and of agriculture; and the farmer who invests his time, his labor, and his very life in the effort. But each of these must depend, necessarily, upon the counsel and the skill of the engineer without him the other could not carry on. It is to him that this first annual hydraulic dam issue of Modern Irrigation is dedicated.



Artist's conception of the San Gabriel Dam, as it will appear on completion in 1932.

Bids on Big San Gabriel Dam, $25,000,000 Flood Control Project, to Be Opened July 11

THE San Gabriel Dam, Los Angeles County Flood Control Project, which will be the largest structure of its kind ever built in the west and the highest in the world, will soon be under way. The district has advertised for bids and these will be opened July 11.

As a special supplement to this issue MODERN IRRIGATION presents to the hydraulic engineering fraternity exact reproductions of the detail drawings of the dam as designed by S. M. Fisher, chief designing engineer for the district and approved by C. E. Eaton, chief engineer. The maximum height of the dam, from foundation to crest, will be 438 feet. It will be 360 feet thick at the base and 30 feet thick at the top. The length of the crest will be 2200 feet and there will be a 20-foot roadway, with a 5-foot walk on each side, to accommodate vehicular and pedestrian traffic over the dam. A series of arches on the downstream face will support this roadway.

The dam is of the gravity type, arched on the upstream face to a radius of 1400 feet. It was planned both for flood control and for the storage of irrigation and domestic water supplies for the valley below. A great number of borings at the base of the proposed structure have been made, in order that the engineers working on the design might have authentic information relative to the definite requirements of the structure. Over 9000 feet of cores have already been taken from 150 diamond drillings, and the information obtained from this work has been made available to the contractors bidding on the job.

To Cost Over $25,000,000

The five spillways will be of the syphon type, and there also will be an outlet tunnel 14 feet in diameter. There will be eight flood control outlets 90 inches in diameter fitted with open nozzles. These outlets will be 178 feet above the stream bed, with their intakes 86 feet higher; there will be seven 60-inch service outlets with gates 100 feet above the stream bed, and four sluice outlets 60 inches in diameter with gates 50 feet above the stream bed.

The estimated cost of the San Gabriel Dam is in excess of $25,000,000, and the time required for its construction has been placed at four to five years. From the very nature of the job only the larger construction companies operating in the United States will be able to bid because the financing of the structure is beyond the means of the average contractor. It is estimated that the successful bidder will be required to have at least $2,000,000 of his own money in the revolving fund necessary for current operations. The successful contractor will be required to furnish a bond equivalent to fifty per cent of the construction cost with the board of supervisors. This money is to insure the completion of the structure and the payment of labor and materials by the contractor. It will require the combined efforts of several surety companies to underwrite such a large order, and the bidder who is not able to obtain such a bond cannot hope to get the contract. In order to lighten the load on the contractor the board of

(*Continued on Page 83*)

Types of Storage Dams and Their Particular Adaptation to Western Conditions

Round Head Buttress Type, the Latest Development in Dam Construction, will Cost 30 to 35% Less Than Ordinary Gravity Dam

By FRED A. NOETZLI

Consulting Hydraulic Engineer, Los Angeles, California

FOR thousands of years, men have built dams of earth, wood, masonry and other materials, to store water in reservoirs, or divert it into new channels.

One of the most ancient dams of which we have a record is the Marduk earth-fill dam on the river Tigris. It

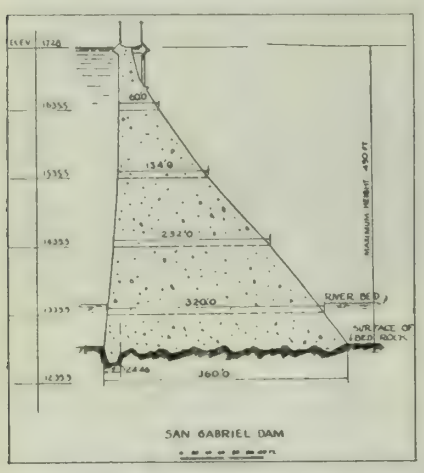


Figure 1. Cross section of the San Gabriel Dam, a typical gravity type dam.

was built in pre-historic times and survived the Chaldean, Assyrian, Persian, Greek and Roman dominations, but failed at the end of the 13th century of our era at the time of the Mongol invasion.

The first masonry dam on record was built on the river Nile some 6,000 years ago by Menes, the first king of the first Egyptian dynasty. It was constructed of cut stone masonry, and ruins of it are still in existence. It was about 50 feet high and 1500 feet long. The dam was kept in perfect condition for a period of more than 45 centuries, but was neglected and ruined during the Caliph's domination.

Largest Masonry Dam

Probably the largest masonry dam ever built was 120 feet high and two miles long, and is estimated to have contained over 15 million cubic yards of masonry, the thickness at the base being nearly 500 feet. This dam was built about the year 1700 B. C. in connection with irrigation works in Yemen, Arabia. It lasted for nearly 2000 years, but was neglected and failed at the beginning of the third century of our era, after having shown signs of distress for many years before the final collapse.

In building masonry dams, the Egyptian and Chaldean engineers appear to have generally followed the rule of making the base of the dam four times the height. All masonry dams were of the overflow type. The Romans and Moors, who built many masonry dams, especially in northern Africa, made some progress in dam design in reducing the width of the base to three times the height.

The French engineers advanced in the 19th century the first rational theory of masonry dams. Profiles of gravity dams according to mathematical principles were devised by De Sazilly, Delocre, Bouvier and others. In this country, Wegmann made his classical studies on gravity dams during the eighties of the past century, and established rules for design, which have been used extensively ever since.

Modern Types

The rock-fill and hydraulic fill types of dams are largely a product of the engineering skill of men of the American West. The late John S. Eastwood deserves the credit of havinug developed the modern type of multiple arch dam, while L. Jorgensen has shown by many constructions the advantages of the variable radius or constant angle arch type. A more recent type of dam, the multiple dome, was devised by C. R. Olberg. Many other western engineers, among whom figure prominently Brown, Hawgood, Hill, Henny, Howells, Marx, Schuyler and Wiley, have been identified with improvements in the methods of design and construction of dams of various types.

In the semi-arid sections in the western parts of the United States the storage of water for irrigation and power purposes, as well as for municipal uses, is of great economic importance. In California, three-fourths of all the waters reach the ocean within two months after the time of their precipitation as rain or snow upon the mountain areas. Similar conditions obtain in most of the western states, and the full development of the water resources of these states can be attained only through the construction

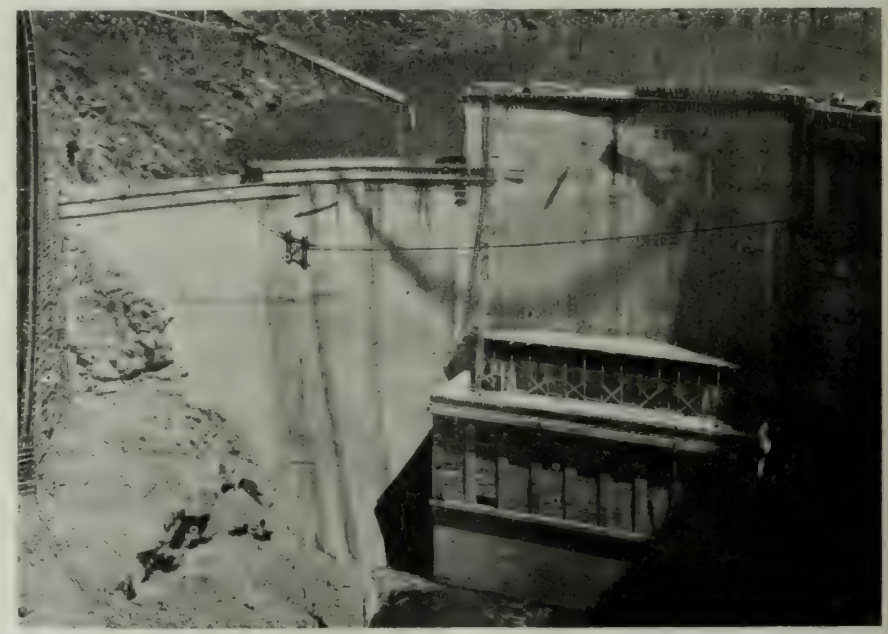


Figure 2. The Horse Mesa Dam located on the Salt River is a good example of the single arch type structure.

of dams and the release of the impounded waters for use at the needed time and place.

Big Development in West

No two dams sites are exactly alike. Many different types of dams have, therefore, been devised by engineers to suit best the conditions of the different sites. The western United States especially has been prolific in producing new and economical types of dams, and the pioneer spirit and ingenuity of western engineers is responsible to a large extent for the economic feasibility of many irrigation and power developments. Much earnest effort was also spent in developing scientific methods of design, especially for dams of the arch and multiple arch type. The recent construction and testing of the Stevenson Creek experimental arch dam by the Engineering Foundation Committee is the crowning achievement in this direction.

It is of interest to note that no masonry dam of importance has failed in any of western states. The list of failures of earth and rock-fill dams, however, is long and very impressive.

Earth Dams

Embankments built of earth are probably among the first types of dams built for storing or diverting water. Earth dams are being built extensively in the west, especially where the foundation conditions are not suited to the construction of a concrete dam, and where suitable material is available for an earth embankment. If the proper care is exercised in the construction, the product will be a dam, otherwise—a failure.

Many earth dams leak in spite of all precautions. Various schemes have, therefore, been used for making dams of this type more nearly water-tight. Rolling, wetting and tamping of the fill material in thin layers has proven successful in case of dams of moderate height. For larger structures the hydraulic and semi-hydraulic process of placing the fill material, has proven in many cases to be a great improvement over the ordinary methods.

Cores of clay puddle, masonry or concrete, placed approximately in the center of the earth-fill, have greatly improved the water-tightness of earth dams. In some cases the upstream face was paved with a thin slab of reinforced concrete. A flexible composition membrane composed of two thin slabs of concrete or gunite and placed in the up-stream third of the fill, has also been proposed.

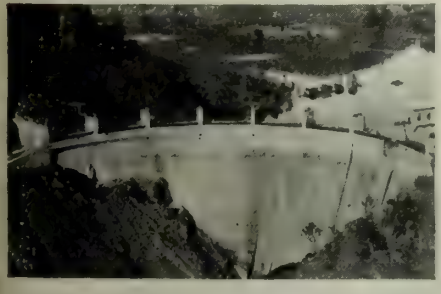


Figure 3. The Melones Dam, on the Stanislaus River is another gravity arch dam, utilizing to some extent the arch action for its stability.

Figure 5. The Pacoima Dam, which is rapidly reaching completion, is probably the highest arch type structure in the country. It is a part of the Los Angeles County Flood Control Project.

Rock-Fill Dams

Dams of the rock-fill type are generally considered to offer the greatest economic advantages at sites located at great distances from railroad transportation, especially at sites where the rock for the fill can be quarried at relatively small expense. In some dams a considerable part of the fill was placed directly by blasting rock material from the hillside.

Although most rock-fill dams in the United States were built in the western states, the highest dam of this type, the 270-foot Dix River Dam, is located in the East. Rock-fill dams must have an impervious membrane, either of steel or other suitable material, preferably reinforced concrete. While for relatively low dams a concrete face slab has sufficient

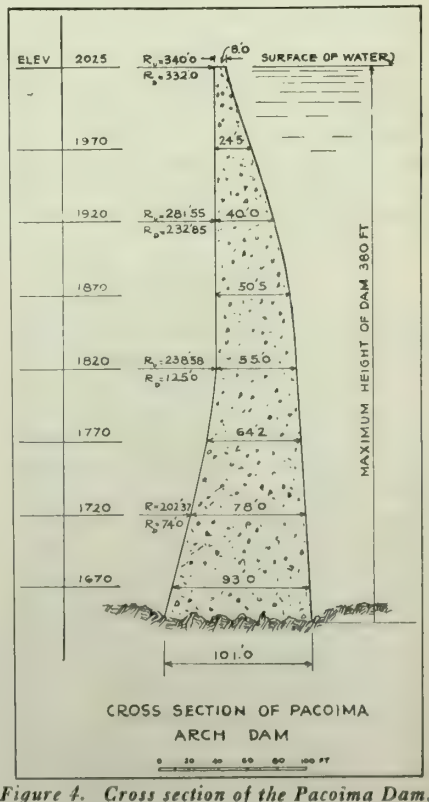


Figure 4. Cross section of the Pacoima Dam.

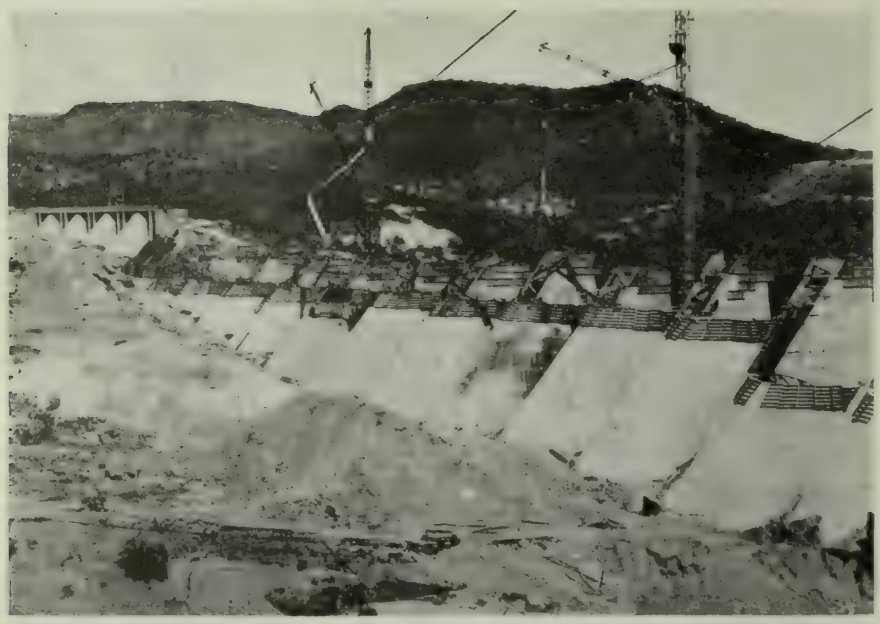


Figure 6. The Lake Pleasant Dam, on the Agua Fria River, Arizona, will be the highest multiple arch dam in the world when completed. Detailed description will be found elsewhere in this issue.

ent flexibility to allow the slab to follow the settlement of the fill material without developing serious cracks, this type of construction for very high dams has not yet stood the test of a sufficient length of time to warrant definite conclusions. The settlement of the fill may continue for five to ten years, and in cases where the rock of the fill material is likely to slack or decompose, the settlement may continue almost indefinitely.

The earth and rock-fill type of dams have proved to be well adapted to western conditions, if properly constructed.

Timber Dams

Dams built of timber were used extensively during the early gold mining operations in California. Timber dams may be suitable for temporary purposes but they should not be used, except for dams of little importance, if permanency is required.

Steel Dams

Several attempts have been made to build dams of structural steel. Unfortunately, most of these attempts resulted in failures though probably for no fault of the structural members themselves. It is, however, doubtful whether steel could be permanently protected against rusting especially in joints and connecting members not readily accessible for inspection, painting and repairing. It would appear that for hydraulic structures, like dams, concrete or reinforced concrete would be more permanent and quite likely also less expensive, especially in the western states.

Gravity Dams

Gravity dams, as is implied by the name, depend for stability entirely on their weight. The dams built by the ancients had a bottom width of three to four times the height. The French engineers and Wegmann reduced this bottom width by the introduction of a rational theory to 0.67 to 0.80 times the height. Especially Wegmann's studies, as published in his well-known treatise on dams, have laid the foundation for a

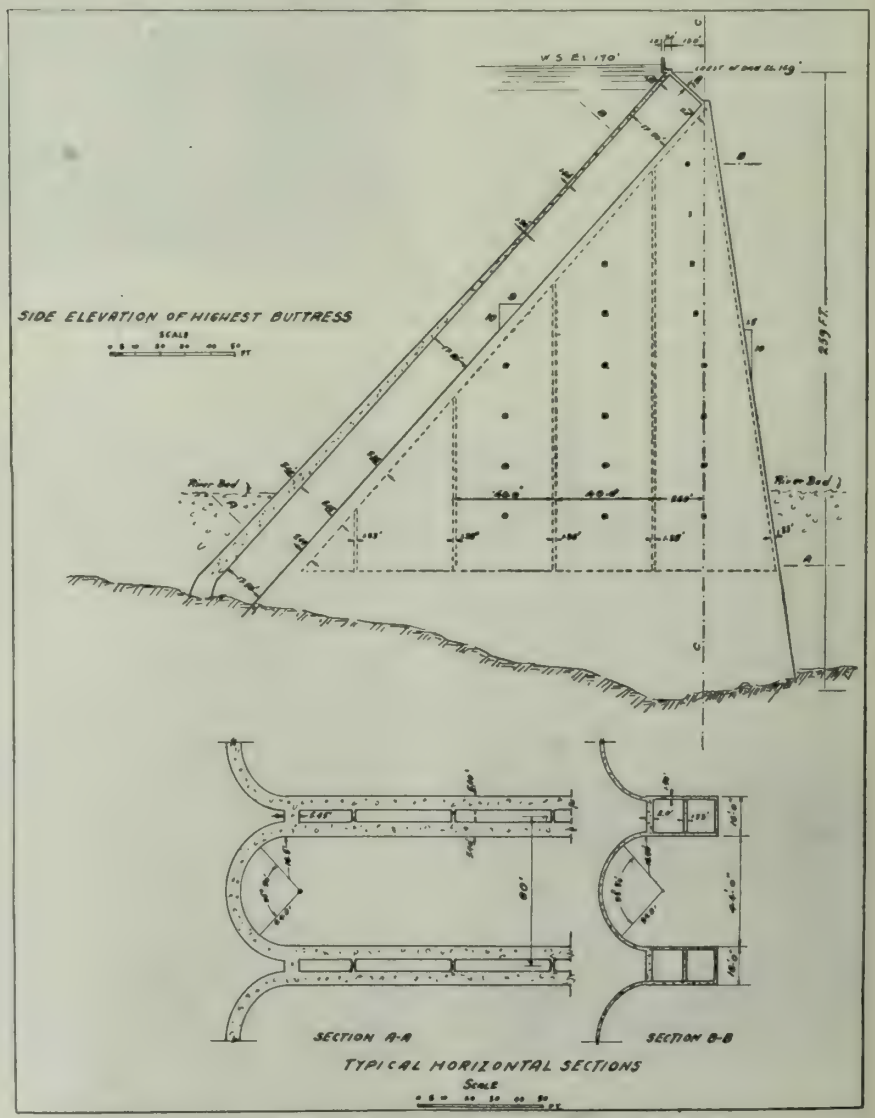


Figure 7. Cross section of the Lake Pleasant multiple arch dam.

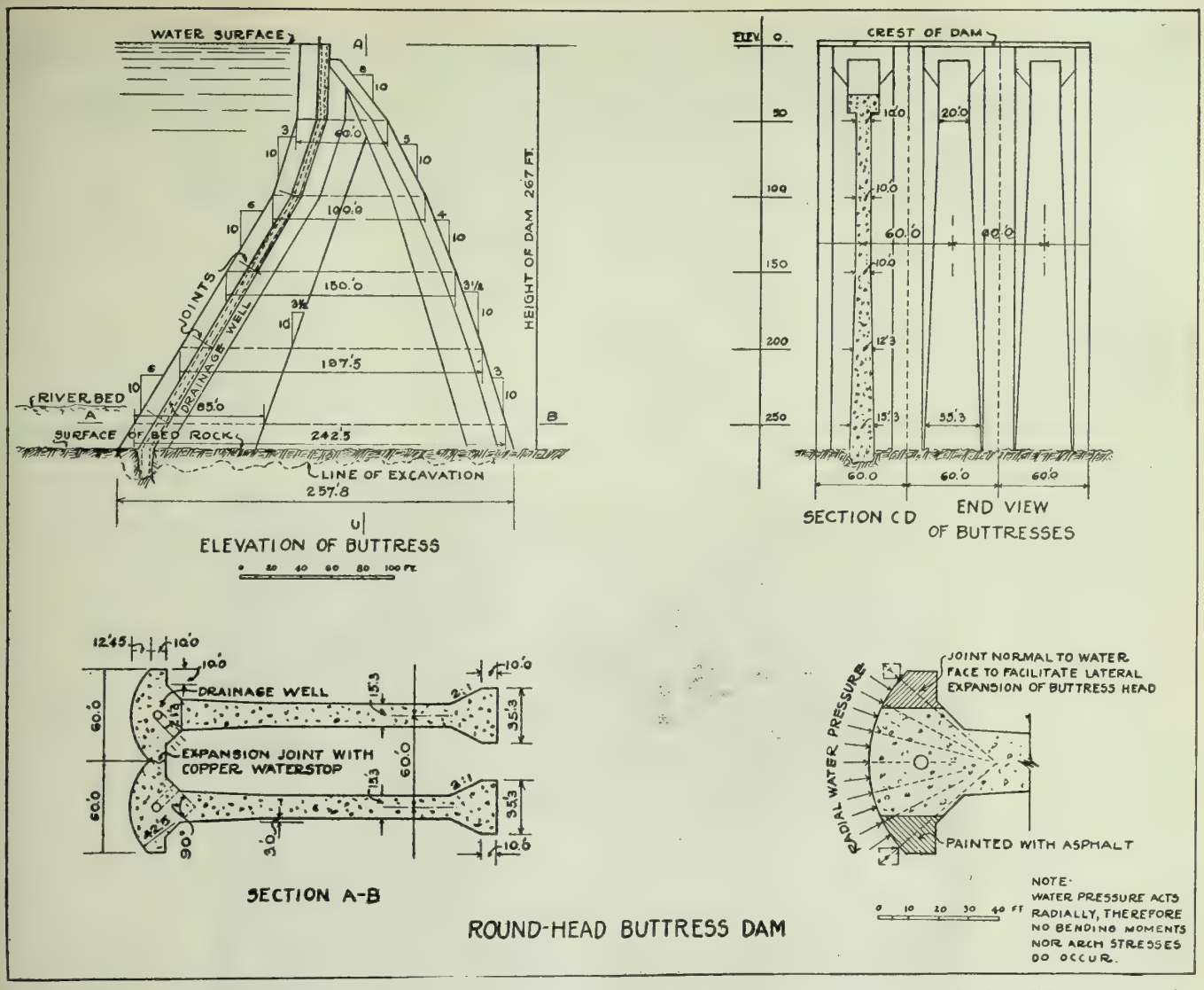


Figure 8. The Round Head Buttress Dam, a new type structure which has been developed by the author of this article. The use of this type of structure enables a saving in quantity of concrete of about 45 per cent over an ordinary gravity type dam. The saving in cost may be 30 to 35 per cent.

standardization of practice in the design of gravity dams. Many gravity dams built during recent years in the East and in the West have been designed by the methods given in Wegmann's book.

Some gravity dams have been built straight in plan. In the western states most dams of this type are slightly curved in an up-stream direction. While it is generally recognized that a curved gravity dam does not develop arch action under ordinary conditions, the curvature may nevertheless increase considerably the ultimate factor of safety in case of a tendency of overturning or sliding of the vertical section under extraordinary conditions, and thus possibly prevent a failure.

Conservative engineering requires that gravity dams be designed for up-lift. Theoretical investigations and actual measurements on some dams clearly indicate the necessity of increasing the thickness of gravity dams to take care of such up-lift forces, unless the up-lift pressure is guarded against in some other way. In the western states it is customary to pressure grout the bedrock and in addition to provide drainage holes in the bedrock and in the dam near the up-stream face so that seepage water may escape harmlessly from underneath the dam.

Arch Dams

Many gravity dams of great height have been built in the western states. The Roosevelt Dam in Arizona, the Elephant Butte Dam in New Mexico, the Arrowrock Dam in Idaho, and the Don Pedro, O'Shaughnessy and Exchequer Dams in California are among the best known dams of this type. Construction will soon be started on the San Gabriel Dam near Los Angeles, which will have a height above bedrock of practically 450 feet. (See Fig. 1.) Before long, the building of the Boulder Canyon Dam, to be 700 feet high and creating a reservoir of 25,000,000 acre-feet, may be undertaken.

The Zola Dam in France, built about the year 1843, and having a height of 120 feet, is the first single arch dam of which there is a record. Although entirely successful, this type of structure was not used in other countries, until in 1884, F. E. Brown astounded the engineering fraternity by the bold construction of the Bear Valley Dam in the San Bernardino Mountains. Failure of this dam was freely predicted by most engineers, but many years of successful service during which the dam was subjected in flood times to as much as 3 feet of over flow, and in some winters to the pressure of over 2 feet of ice, have demonstrated that dams of the arch type have apparently a much greater strength than was believed by most engineers.

During the past twenty years there have been built in the western parts of

(Continued on Page 90)

Interesting Features of the Construction and Testing of the Stevenson Creek Arch Dam

Discussion of the Results of Experiments Adds an Important Chapter to Engineers' Investigation; Further Tests Planned

By W. A. SLATER

Engineer-Physicist, United States Bureau of Standards

A COMMITTEE of Engineering Foundation, with the cooperation of the U. S. Bureau of Standards and the University of California, and with the generous financial support of many commercial and governmental organizations, and individuals, is carrying on an extensive investigation of concrete arch dams, with the purpose of establishing a sound and economical basis for their design.

Of this investigation the construction and testing of a dam 60 feet high and 140 feet long at Stevenson Creek near Fresno, California, is an important and spectacular element. The writer, representing the Bureau of Standards, has been in charge of the testing and of the interpretations of results of the test.

MODERN IRRIGATION for January, 1927, gave the story of the Stevenson Creek Experimental Arch Dam up to that date. This story gives interesting features of the construction and testing of the dam. The present article gives some results from the test. The drawing of conclusions, however, is avoided as it seems best not to attempt this until the report is complete.

On October 1, 1926, the testing staff moved from the site of the test to Los Angeles and have since been working up the data. It has become evident since completing the tests that some data were omitted which should have been taken, and for some of the data taken, no use has been found. This condition is almost inevitable in a project of such magnitude in which the methods of interpretation continue to develop as the study of results progresses. On the whole, however, the occasions for regret at the course pursued are few.

TESTS BY FLOODS

After completion of the program of test, the stop-logs closing the sluice beneath the dam were removed with the expectation that all water entering the reservoir would be drained through this opening. In November, 1926, a severe storm caused a flood which deposited so much rock, debris, and sand in the reservoir that the undersluice was choked and the reservoir filled with water. It is probable that the wrecking of the scaffolding helped to choke the undersluice. The depth of the debris at the upstream face of the dam was generally about 40 feet on January 5, 1927. Water has been running over the top of the dam all winter and up to the present time. At the height of the storm, the depth of water on the crest of the dam reached as much as three feet. The water, together with the debris carried by it, washed out or battered down the observation platforms on both the upstream and the downstream faces. The stems of the 24-inch and the 6-inch valves and the wiring of the electric telemeters close to the face of the dam were torn loose.

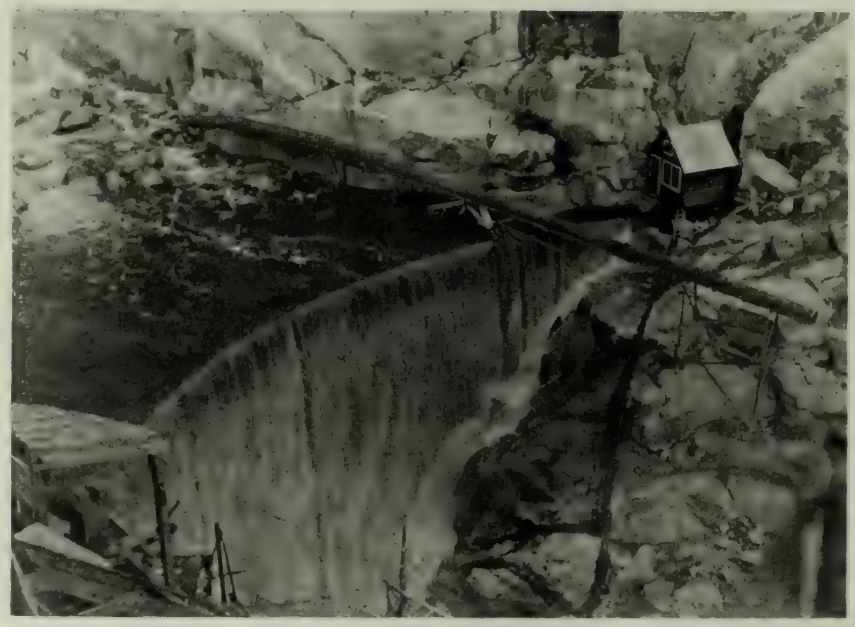


Figure 1. Conditions at the Stevenson Creek test dam following the severe storm of November, 1926. The underslice became choked and at the height of the storm the water on the crest of the dam reached a depth of three feet.

Figure 1 shows the conditions at the dam shortly after this storm. It has not been possible to make any observations with clinometers or telemeters since the storm, but observations of deflections made with the theodolite on January 5, 1927, on points placed at the crest of the dam, indicate an increase in the downstream deflection as compared with that for the 60-foot head, September 22, 1926, of about 0.1 inch at the center line and 0.2 inch at points 30 feet away from the center line.

An inspection of the dam on January 5, when about one-half inch of water was flowing over the crest, indicated that the cracks had not extended appreciably in length, nor had the crack in the upper part of the dam increased noticeably in width. The crack at the bottom of the dam, however, was wider, and, whereas on October 1, it stopped about three inches from the bottom, on January 5 it had extended all the way to the bottom. On the whole, it may be said that the dam had been little affected by the severe test given it by this storm.

In February, 1927, another severe storm visited the vicinity of the dam. The water was again at a high elevation and it is most likely that the debris will be found to be considerably deeper than on January 5, but no detailed examination has been made since that time. Inspection from a distance, however, indicates no important change in conditions since the examination made on January 5.

Owing to the expense which would be entailed in clearing debris, rebuilding platforms and restoring instruments, it has not been possible to make cold-weather tests which had been planned. However, further study of the data indicates that more information on the effect of temperature alone had been obtained in the period before water pressure was applied than was suspected at the time. These data may furnish information of some value on temperature effects.

Cracks and Their Significance

Early in the testing operations, under a head of 30 feet of water, a horizontal crack appeared approximately at the center line of the dam between its bottom and the foundation on the upstream side. During later tests to higher heads successive openings of this crack were measured by means of an electrical resistance instrument (here termed the resistance micrometer) operating under water. Figure 2 shows the amount of opening. Although agreement under the same head of water is not perfect, it is sufficiently good to show that the measurements are significant of the opening of this crack. It is not unlikely that difference in temperature for successive tests would be sufficient to cause the cracks between the dam and the abutment near the top of the dam to vary in width before the application of pressure. Such a variation in width of the upper cracks would cause an opening of the crack at the bottom to start earlier or later, depending on whether the upper cracks were wider or narrower. For these reasons the variations, shown in Figure 1, of the width of the crack at the bottom do not seem greater than might be expected.

In the January article in Modern Irrigation it was reported that under a head of 50 feet a vertical crack appeared on the vertical center line of the dam, extending from the top down to elevation 49 feet on the donwstream face. Measurements were taken in later tests showing the variations of the width of this crack with variations of the head of water against the dam. Figure 3 shows that the crack began opening under a head of a very few feet and continued to open until a head of from 45 feet to 50 feet had been reached and that from that time on until the water reached the top of the dam the crack closed progressively. The indications of a negative opening of the crack on the upstream side of the dam under the full head (60 feet) may be satisfactorily explained by assuming that the crack was slightly open when the zero reading on this instrument was made. Therefore, the diagram would indicate that the crack was further closed at the top of the dam with the reservoir full than with it emptied.

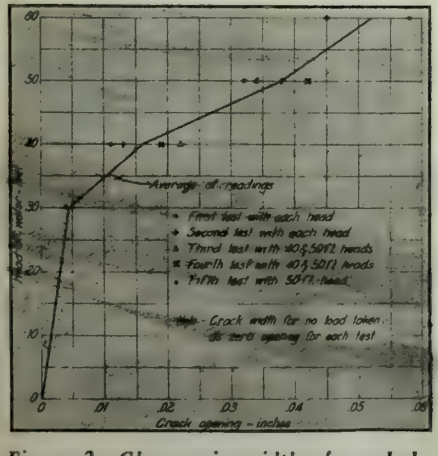

Average of readings
First test with each head
Second test with each head
Third test with 40 & 50 ft heads
Fourth test with 40 & 50 ft heads
Fifth test with 50 ft head
Crack opening - inches

Figure 2. Changes in width of crack between dam and bed-rock on up-stream side at elevation 2 feet. Tests 6 to 12 inclusive. Crack occured in test 4 with water at 30 feet.

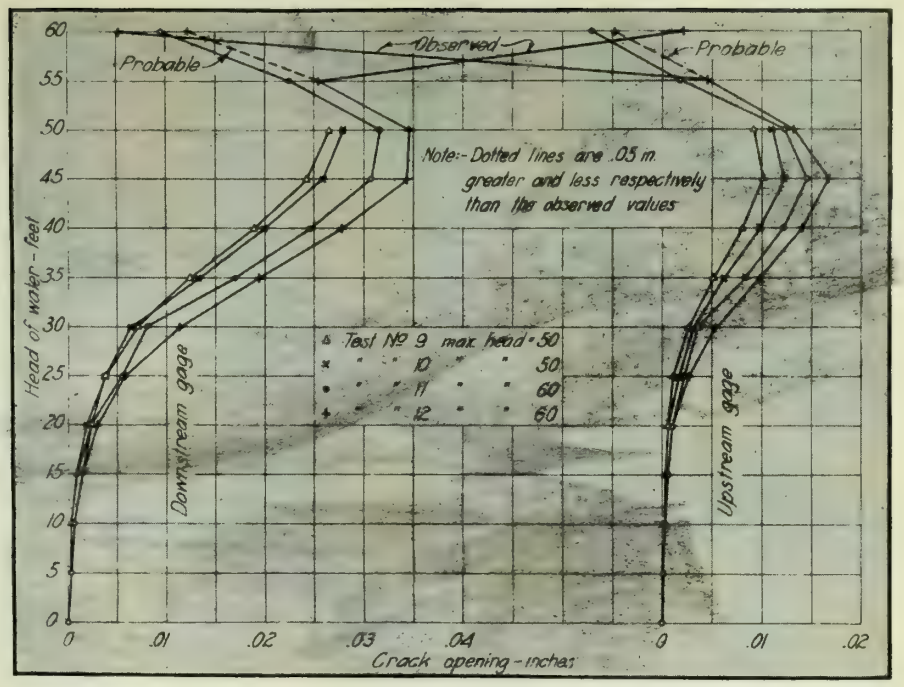

Observed
Probable
Probable
Note:- Dotted lines are .05 m. greater and less respectively than the observed values
Test No 9 max. head = 50
" " 10 " " 50
" " 11 " " 60
" " 12 " " 60
Head of water - feet
Downstream gage
Upstream gage
Crack opening - inches

Figure 3. Changes in width of crack in dam at crown elevation 60 feet.

Spreading of Canyon Walls

The amount of spreading of the walls of the canyon due to arch thrust is shown in Figure 4, with corresponding heights of water. These measurements were taken along the long chords at the 17-foot and the 33-foot elevations. A ⅜-inch invar steel bar was attached to a heavy steel plug imbedded in the bed-rock at the north end of the dam at each of these elevations. Each bar extended along the direction of the long chord to a corresponding point at the south abutment, where the end of the bar bore against the plunger of an Ames gage attached to another plug imbedded in the bedrock. Thus the total change of distance between the ends of the chord was transmitted to the Ames gage. The readings gave the sum of the movements at the two end points. It is the total movement along the chord length that is plotted in Figure 4. In the analysis of the results, these data of the spreading of abutments, taken largely as a matter of general interest, have proved unpectedly useful in determining the direct strain in the horizontal elements as distinguished from the bending strains.

The remarks concerning Figures 2, 3, and 4 have been made as though the measurements were taken as the head of water increased, but actually the readings were taken during the lowering of the water. This procedure was followed because, whereas the filling of the reservoir generally occupied several hours, the emptying took place within a few minutes. Temperature corrections for changes within the few minutes would be too small to take into account. Although the coefficient of expansion of the invar steel was only 0.0000012 inch per inch per degree Fahr., it was large enough to demand correction if an appreciable change of temperature had taken place.

Strain Measurements

Figure 5 affords a comparison of the results obtained in the measurement of strains by different methods. The three upper curves show the bending strain at the surface of the concrete along the horizontal element at the 300-foot elevation. The three curves are based upon strains determined by three independent methods, namely, (1) from the difference of strain on the upstream and the downstream faces, as given by the telemeters; (2) by double differentiation of

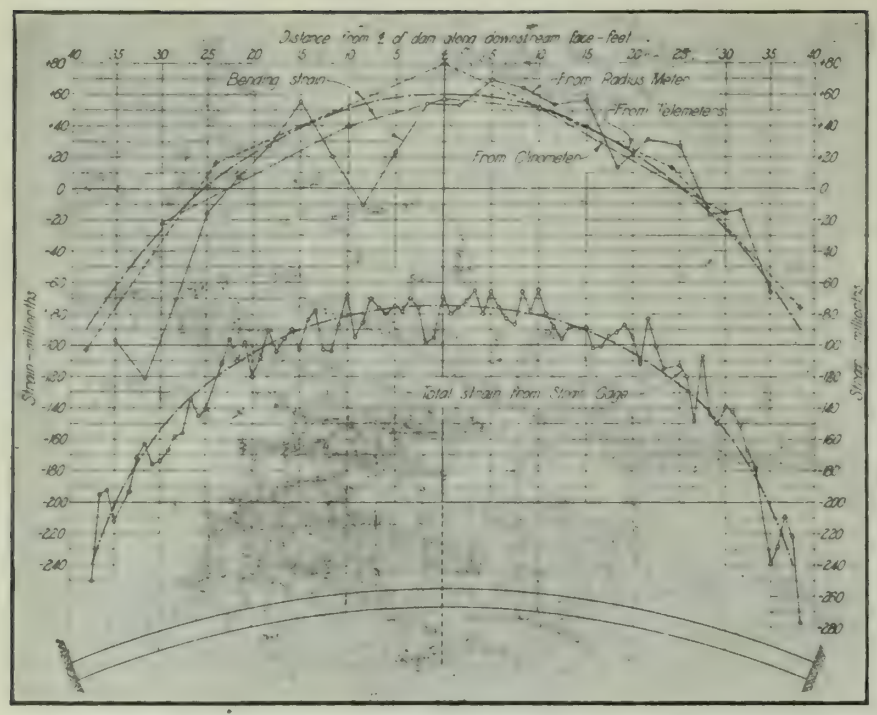


Figure 5. Total and bending strains at 30 foot elevation, measured by four different instruments. Lower figure is plan of dam at the 30 foot elevation.

the deflections at this elevation, found by the use of the clinometer; and (3) from readings taken with the radius meter. The radius meter measured a change in mid-ordinate of a 40-inch arc of the dam. This change in mid-ordinate is proportional to the bending strain, and from the changes in mid-ordinate the values of strain shown in Figure 5 have been determined. The lower curve, marked "total strain from strain gage," represents the sum of the bending and direct strains as measured on the downstream face of the dam. Although an average curve through the data obtained from the strain gage for the total strain is very symmetrical about the center line, there are individual variations from point to point which make a jagged graph. It is not certain how much of the irregularity is due to error in observation and how much to lack of homogeneity of the concrete along the arch ring. It is believed that an appreciable part is due to the latter cause, since irregularities frequently go in groups of three or more points.

The agreement of the three upper curves with each other seems to be good indication that dependence can be placed upon the results obtained. Since the upper curves represent only bending strain and the lower curve represents the sum of the bending and the direct strains, the difference between the two average curves (represented by the vertical distance between curves) is the strain due to the direct axial compression in the arch ring. The indication from this figure is that this direct compression was nearly uniform throughout the length of the arch at this elevation.

Moments, Shears, and Loads

From the observed data of deflections and strains, the moments and shears in the vertical and the horizontal elements have been determined, and the manner of division of the total pressure of the water between the vertical and the horizontal elements has also been determined. As an example, Figure 6 shows the deflections on the vertical center line of the dame under 60-foot head. It shows also the moments, shears, and distributed loads on this vertical element one foot wide as deduced from the deflections above the 15-foot elevation, also the total applied water pressure at the various heights.

Similarly the moments, shears, and distributed loads carried by horizontal elements have been determined. The sum of the loads carried by a vertical and by a horizontal element within the area of their intersection, must be equal to the total water pressure applied within that area. A check on the correctness of the results is, therefore, afforded by a comparison of the sum of the loads carried by the vertical and the horizontal elements, with the total water pressure for the area under consideration. Although this agreement has not been perfect, it has been sufficiently good to give confidence that a good general idea is being obtained of the manner in which the load is carried to the abutment and foundation. See Figure 6.

At places where the data of the tests do not permit the independent determination of the loads carried by the vertical and the horizontal elements, it is necessary to determine one by deducting the other (which is known) from the total water pressure over the area of their intersection. For such cases the check above referred to is not available. For the 5 and the 10-foot elevations the loads determined for the vertical elements were in doubt, and the loads shown in Figure 6 for those elevations were obtained by subtracting from the total water pressure the loads carried by the horizontal elements. The load at the bottom is shown as the total water pressure.

In Figure 6 the plotted points for the deflections represented by a dotted curve were obtained from direct measurements, and the plotted points for moment (represented by a dotted curve) were obtained by differentiations of the observed deflections. The solid curves are the results of successive integrations of the load curve. The agreement between the plotted points and the solid curves for deflection and moment indicates that the loads shown correspond closely to the deflections observed. Even below the 15-foot elevation where other methods of determining the load were employed, the agreement with the deflection is good.

The shear curve gives the total shear carried on the section. To obtain the average shearing unit stress for any elevation, the total shear indicated must be divided by the sectional area of the element.

Of the three graphs at the extreme right of Figure 5, the points plotted as circles indicate the loads per foot of height carried by the central vertical element one foot wide and transmitted as shear to the bottom of that element. To the loads carried by the vertical elements have been added the loads carried by various horizontal elements one foot wide within the area of their intersection with the central vertical element of the dam. The sums of the two loads (those carried by the vertical and horizontal elements, respec-

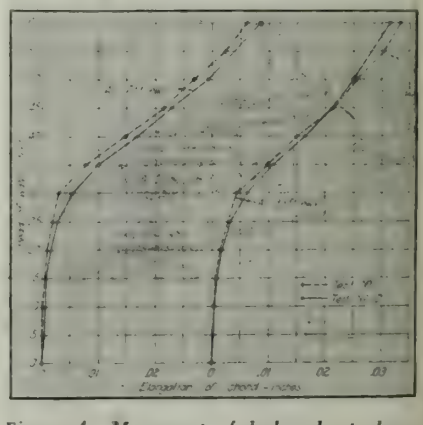


Figure 4. Movement of bed-rock at elevation 17 and 33 feet.

tively) should be equal to the total water pressure per square foot at all elevations. The total water pressure is shown as a straight line so that the agreement may be noted.

Progress of the Work

In the preparation of the report the data taken in the tests under 60, 50, and 40-foot heads have been reduced to moments and shears at various parts of the dam. Also, the loads carried by the vertical and horizontal elements in bending and direct compression have been determined as far as the data seem to afford a basis for that determination. It is believed that when the data are assembled, together with the necessary discussion, a fairly accurate picture of the behavior of the dam will be available. This will not be the solution of the arch dam problem, but it is believed that its results will afford a criterion by which the results of the analysis may be judged as to soundness and the relative importance of many of the elements considered.

As a further step in the investigation, arrangements have been completed with Prof. H. M. Westergaard of the University of Illinois, to undertake on the basis of the test data and the principles of mechanics, to develop an accurate empirical solution of the arch dam problem. It is hoped not merely to arrive at a solution, but also to place the results of the analysis in such form as to make of them a practical means for the design of arch dams.

Tests of Models

Tests of models are also being planned. The first purpose of the models must be to determine whether the results of tests on the models agree with the results of the test of the Stevenson Creek dam in conformity with dimensional analysis of the model. Assuming this to have been established, the testing of models should then afford a means of covering a larger field than is possible through the testing of full-size dams.

Testing Staff of Arch Dam Committee: Left to right, Glade Berry, L. J. Marchand, W. A. Slater, A. Y. De Yoe, Inge Lyse, R. W. Carlson, J. Stout.

At Denver, under the auspices of the Sub-Committee on Models, the Reclamation Service is preparing for the testing of a model of the Stevenson Creek Dam and a model of an arch dam about 900 feet long and 175 feet high to be built in Montana. The scales for these models are one-twelfth and one-fiftieth of full size, respectively. That is, any dimension in the model is to be one-twelfth or one fiftieth of the corresponding dimension in the full-size specimens. The models are to be constructed of cement mortar and it is planned to use mercury as a loading material. While methods of measurement have not been entirely settled, it is probable that at various points the deflections within a span of 10 inches, due to the change of curvature, wil be one of the important measurements taken. Since this deflection is proportional to the bending stress (so long as the modulus of elasticity is constant), these data should afford a basis for determining the bending loads. Other data will be required for determining the loads causing direct compression.

At Princeton University, Princeton, New Jersey, under the direction of Prof. Geo. E. Beggs, a test is being carried out on a model of the Stevenson Creek Dam by D. B. Sloan, a graduate student. This model is of celluloid and is one-fortieth full size. Here also it is planned to use mercury as the loading material. Strains are being measured by means of a microscope. A portion of the cost of the investigation is being defrayed by the Power Division of the American Society of Civil Engineers.

Further tests of Stevenson Creek Dam at its present height and at increased heights depend first of all upon the raising of additional funds. Such tests will be of value after the report has been completed on the tests to date and after the projected mathematical study and the tests of models have given a better background for the planning of the tests.

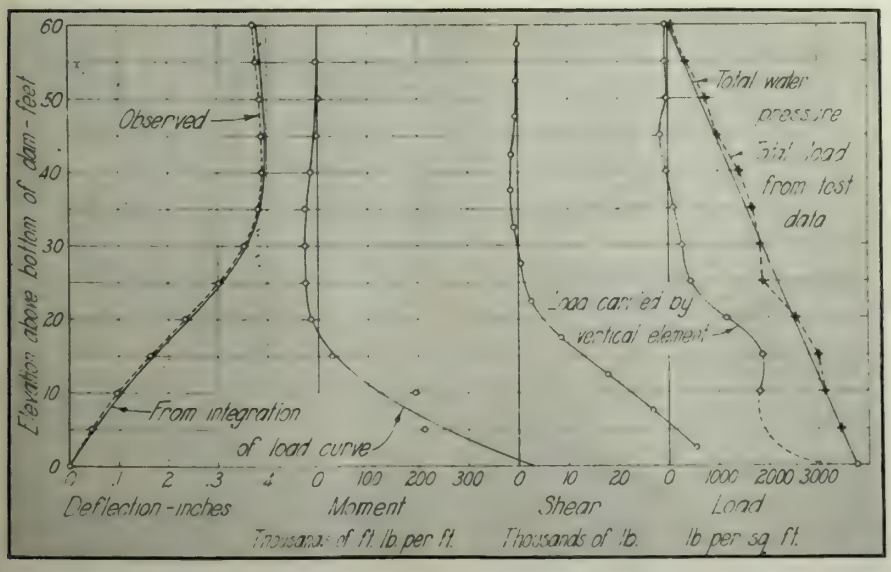
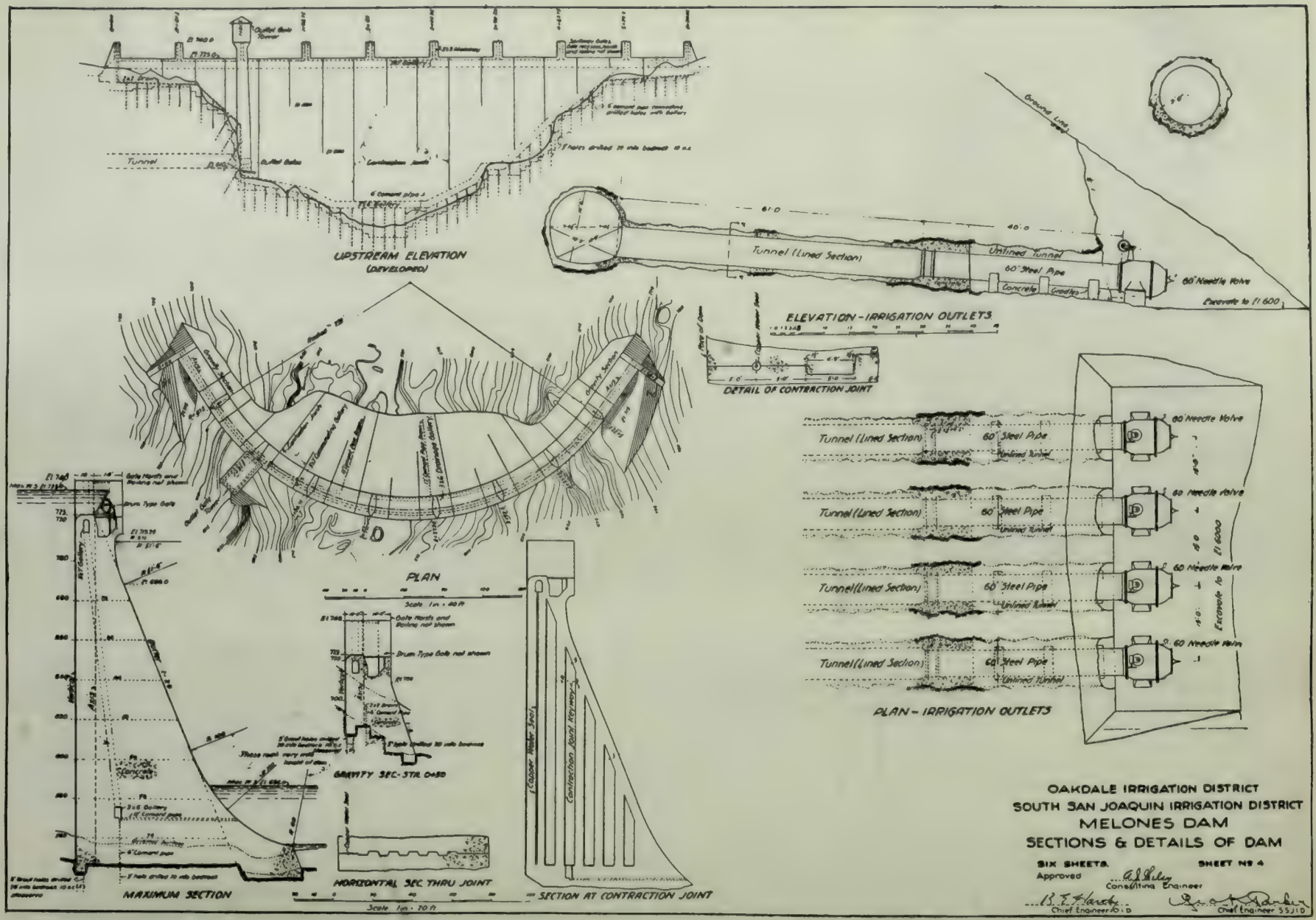


Figure 6. Deflection, moment, shear and load for central vertical element under 60 foot head of water.

Yakima Valley Irrigation

The acreage under irrigation in the Yakima Valley, Washington, is reported by the superintendent of the Yakima Project to be 350,000, according to a recent statement by the Bureau of Reclamation, Department of the Interior. Value of storage properties is placed at $3,800,000.


UPSTREAM ELEVATION
(DEVELOPED)
Tunnel (Lined Section)
Unlined Tunnel
60" Steel Pipe
Concrete Cradles
60" Needle Valve
Excavate to El 600
ELEVATION - IRRIGATION OUTLETS
DETAIL OF CONTRACTION JOINT
PLAN
Scale 1 in = 40 ft
Tunnel (Lined Section)
60" Steel Pipe
Unlined Tunnel
60" Needle Valve
Excavate to El 600
PLAN - IRRIGATION OUTLETS
GRAVITY SEC - STA 0+50
HORIZONTAL SEC THRU JOINT
Scale 1 in = 20 ft
MAXIMUM SECTION
SECTION AT CONTRACTION JOINT
1" Copper Water Seal
Contraction Joint Keyway
OAKDALE IRRIGATION DISTRICT
SOUTH SAN JOAQUIN IRRIGATION DISTRICT
MELONES DAM
SECTIONS & DETAILS OF DAM
SIX SHEETS.
SHEET NO 4
Approved
Consulting Engineer
Chief Engineer O.I.D
Chief Engineer S.S.J.I.D

Melones Dam Good Example of Present Day Less Than Gravity Type of Structure

Project Irrigates Some 150,000 Acres Comprising Two Districts in San Joaquin County; Power Agreement a Feature

By F. P. BASLER
Secretary, Mathews Construction Company

THE Melones Dam is an excellent example of modern construction of the old type less than gravity section dam. The Melones Dam derives its name from a small town on the Stanislaus River a short distance above the site of the dam. The exact location of the dam is 10 miles above the town of Knights Ferry on the Stanislaus River, which is the dividing line between Tuolumne County and Calaveras County, in Section 11, T. 1 N., R. 13 E. The project was conceived for the purpose of irrigating approximately 150,000 acres of land comprising the Oakdale Irrigation District, and the South San Joaquin Irrigation District, both in San Joaquin County.

The irrigation of the lands owned by the Oakdale Irrigation District has been under consideration for a number of years, but the first direct movement took place in 1922, when A. J. Wiley, a consulting hydraulic engineer of national reputation, was engaged to make a report, which was submitted in August, 1922. Subsequent development has substantially followed the plans submitted at that time. Five per cent bonds, maturing over a 40-year period were issued for the total estimated cost of the project—$2,200,000. The Oakdale district sold its entire share amounting to $1,100,000 to a syndicate composed of the Anglo & London Paris National Bank, First Securities Company, J. R. Mason Company, and Freeman Smith & Camp Co., for $1,087,185 or at a 2 per cent discount. At the same time the San Joaquin district made a partial sale of $900,000 worth of securities to the same parties for $888,888. The remaining $210,000 worth of securities were sold on June 8, 1926, to a syndicate composed of Wm. Cavalier Co., American Securities Co., and E. R. Gundlefinger, Inc., for $196,888 plus accrued interest.

Two Roads Built

The project involved the construction of a railroad approximately 8½ miles long, which connected with the existing Sierra Railway at Jacks Siding and extended on a high line to the dam site, the terminus being about 100 feet above the crest of the dam on the south abutment. A wagon road, about four and one-half miles long, was also constructed connecting with the main county highway near Jamestown. Contracts for the construction work on both the railroad and wagon road were awarded to the Mathews Construction Company of Sacramento, California, who had previously been awarded the main contract; and actual work was commenced on July 24, 1925.

R. E. HARTLEY
of Oakdale, Calif., chief engineer of the Melones Project.

The wagon road was the first job to be undertaken, and required about thirty days for completion. Excavating machinery for the removal of the material near the footings was then brought in, and actual work on the dam proper commenced. At approximately the same time, work was started on the diversion tunnel.

In order to handle the construction materials necessary in the construction of the dam, the railroad was built next, the actual length being 9.3 miles. The railroad involved the construction of over 5000 lineal feet of wooden trestle, and about 144,000 yards of cut and fill. The grade ran as high as 3.5 per cent in some places, and the curves ran as high as 50 degrees. The heavy grade and sharp curves were confined primarily to the short distance which the roadbed ran in the canyon of the Stanislaus River, and in order to haul the heavy loads over this short stretch Shay engines were used. The construction of the railroad occupied the greater part of four and one-half months.

Power Feature

A contract was made with the Pacific Gas & Electric Corporation to install a power plant for the development of electrical energy. This contract was signed jointly by the two districts on July 2, 1925, the agreement stipulating that the power company was to construct and operate a power plant, paying the districts $5,175,000 over a period of 40 years. This amounts to $64,687.50 payable every six months for the entire period of the 40-year contract. The power company will control the water from the 31st of October to the 1st of March; but between December 1st and March 1st will release 36,000 acre feet for the purpose of filling the existing Woodward reservoir of the South San Joaquin Irrigation District. The power company also reserved the right to construct other power developments above the Melones site, the water to remain the property of the districts.

The first work performed by the power company under their agreement with the districts was the construction of a seven and one-half mile, 17000-volt transmission line. Current was furnished over this line to operate all of the prime movers used during the construction of the dam. Electrical energy was utilized even in the camp, electric stoves, refrigerating equipment, and heaters of all types being installed by the contractor.

Equipment Listed

The principal equipment used during the construction period consisted of three air compressors of 660-foot capacity; three guy derricks; two Plymouth locomotives with four 4-yard cars; four 8-inch pumps; two 10-inch pumps. The machine shop and forge shop had the usual drill sharpeners, pipe cutters and threaders, lathe, drill presses, forges, etc. Tramways were used in connection with other high line equipment. Concrete was handled by two Norris K. Davis

(*Continued on Page 56*)

PROGRESS ON THE WEST SPILLWAY TO APRIL 15

The limits of the west spillway excavation are outlined. Power shovels and trucks may be seen at the upper and lower level of this spillway which is of gigantic proportions, the cut on the west spillway being over 140 feet deep in solid rock. On the skyline of this picture may be seen the terminal tower of the transmission line which carries electric energy from the Ray Consolidated Power Plant at Hayden, Arizona, a distance of some twenty miles over very rugged desert mountains to the dam site. In the upper right hand portion of this photograph will be noticed a 100,000-gallon water storage tank which has been built in connection with the construction of the Coolidge Dam and from which a 10-inch pipe-line has been built to the road level.

Dirt Flies for Coolidge Dam

By GRAYDON OLIVER

IN A PICTURESQUE Arizona mountain district close to the waters of the Gila River contractors have erected a nameless town which has most of the conveniences of a modern city. Technically it might be called a construction camp, having been built by the contractors engaged in the construction of the Coolidge Dam, San Carlos Project, Arizona, but it is more than a camp. It illustrates how great an advance has been made during the past few years by large contractors in properly caring for the welfare of their employees on large projects located at considerable distances from centers of population.

The "town" is built around a recreation center which has just been completed. This recreation center includes a motion picture theatre, dance floor, pool room, reading room, card rooms, and a large airy lounging room. The accommodations of these rooms will take care of the crew of workmen who soon will be employed on the dam. It is estimated that there will be nearly 600 men living in the nameless "town" during the construction period.

Large roomy bunk houses have been provided for the single men and these will have all the conveniences of a hotel. Shower baths and tub baths have been installed in these buildings.

A large number of single family dwellings have been built for the men who bring their families. These houses consist of two or three rooms, complete with small kitchens, modern plumbing connections such as sinks, running water, lavatories, etc. When the contractors proposed to erect such elaborate bungalows for their married employees, there was some question raised as to the advisability of the expenditure, but experience has proved that the employees do appreciate and desire these accommodations, and will readily pay an adequate rental for them. All of the family dwellings that have been completed are occupied, and there is a waiting list.

The dwellings are rented at a monthly rate that will amortize and cover the construction cost in a period of twenty months, which is assumed to be the period of construction.

The contractors have also an excellent guest house which is capable of accommodating fifteen or twenty people, and many engineers and public officials connected with the project are taking advantage of the exceptional opportunity afforded them to visit the site of the dam. The guest house, besides having the usual sleeping quarters, has a large lounging room. All floors are of hardwood, and as the winter months bring considerable chilly weather, a fire place for cheeriness and warmth lends a homey atmosphere.

All of the family dwellings, bunk houses, and other buildings have been connected to a modern sanitary system. A septic tank has been built which will take care of this system.

Cook By Electricity

The boarding house has been erected according to the most modern practice. A complete and adequate kitchen is equipped with many kinds of labor saving devices, such as electric bake ovens, dough mixers, ice cream freezers, etc.

PHOTOGRAPH TAKEN AT COMMENCEMENT OF OPERATIONS IN MARCH

Left to right: Mr. Daggett, carpentry superintendent; L. E. Garlinghouse, equipment distributor; E. L. Kier, resident co-partner of Atkinson, Kier Bros. Spicer Company; Robert Lanka, superintendent of material supply for the contractors; Major Charles R. Olberg, engineer in charge; Mrs. Charles R. Olberg; Mrs. C. H. Southworth; C. H. Southworth, construction engineer; C. A. Spicer and Lynn Atkinson of the firm of Atkinson, Kier Bros. Spicer Co., and H. C. Neuffer, engineer in charge of design and survey.

There is a modern ice plant, which, besides providing refrigeration for the commissary, makes sufficient ice for the needs of the private families and the soft drink emporium.

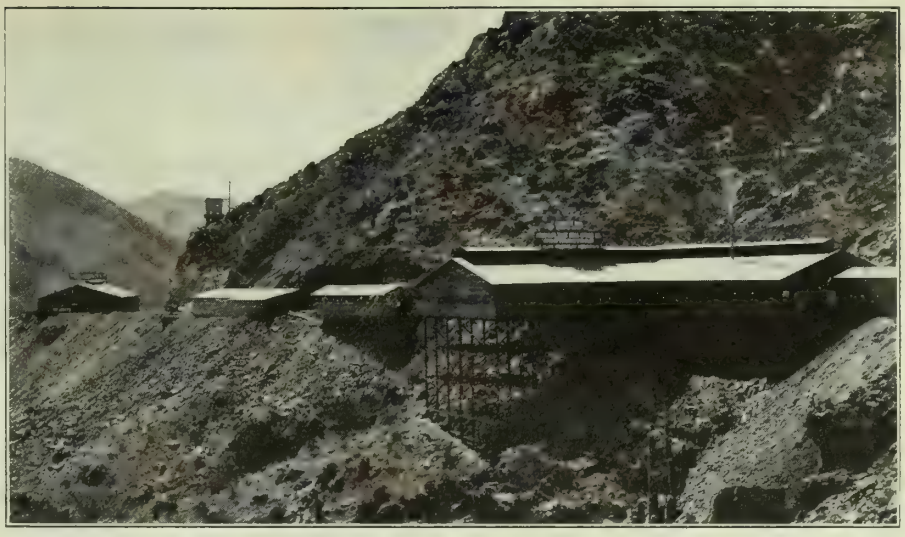
One of the necessities on a project of this magnitude is the equipment and operation of a modern machine shop. The contractors are now completing their shop and it will take care of practically all repair work on equipment. Included in equipment are lathes, forges of different sizes, bolt and pipe threading machines, a new type No. 50 Leyner drill sharpening machine, and an oil furnace for drill heating. The contractors expect to be able to handle over 800 finished sharp drills per day through this plant.

Much of the preliminary work at the site of the Coolidge Dam, has been completed in a satisfactory manner. The erection of the camp itself was quite an undertaking, considering the fact that the location of the site is in southeastern Arizona and distant from any source of supplies. Actual construction on the dam proper has been confined thus far to rock excavations on the hillsides. These excavations are being made primarily for the west spillway and road. This work is progressing nicely, the shovels handling approximately 40,000 cubic yards daily. There are three power shovels in operation which are being worked in two eight-hour shifts. A fleet of motor trucks is handling the waste material from these shovels, some of the trucks being equipped with specially designed bodies to handle the larger sizes of rocks.

Building Diversion Dam

At the present time the contractors are installing equipment for the river diversion and control. This involves the construction of a diversion dam some 300 feet in length, timber cribbing with rock fill. The sluiceway, capable of handling 10,000 second feet, is being developed through the east dome of the main dam. The diversion of the Gila River is one of the important phases of the construction program, as safety to the excavations at the base of the dam depends on the proper operation of the sluiceway system. Probably much of the river excavation will be well along when the Gila is at flood height.

Construction of the gravel plant and mixing plant are now under way. The gravel plant is located about four miles by road from the dam-site, but only 3000 feet air line, so the contractor is taking advantage of this fact by establishing a tram-way from the gravel plant to the concrete mixing plant, which will convey the aggregate at a minimum of expense. All aggregate will be washed and screened, this process taking place at the gravel plant.



THE CAMP AT COOLIDGE DAM SITE

The building at the right is a kitchen and dining room which is capable of handling three hundred men at one sitting. Wash room and garage may be seen at the left. At the extreme left is one of the shop buildings which houses the compressor room and blacksmith shop.

Power Line In

All machinery will be driven by electric motors. In anticipation of the electrical energy which will be developed at the dam, a twenty-mile high tension transmission line has been built from the station of the Ray Consolidated Power Plant at Hayden, Arizona. The course of this line is over a rugged desert mountain country. At the present time power is being delivered from the Ray Company to the dam-site, but the same line will return energy when the dam is completed, and the power house is in operation.

It is anticipated that the actual pouring of concrete will commence early in the fall of this year, at which time river diversion and control will have been accomplished. The foundation construction will probably be completed by January, 1928. The entire construction program should be completed by the fall of 1928, although actual contract time extends to July, 1929. How rapidly the work can be rushed depends entirely upon the appropriations to be made available during the next session of congress.

In connection with the government operations, H. C. Neuffer, assistant engineer, is in charge of the design, and models are now being made to determine the spillway action. Construction supervision is under the direction of C. H. Southworth, assistant engineer.

INDIVIDUAL BUNGALOWS FOR MARRIED WORKERS

These buildings were erected by the contractors and an accurate record kept of cost. They are rented to employees at a monthly rental rate that will amortize and cover this cost over a period of twenty months, which is the assumed period of construction. There is a waiting list.

Lake Pleasant Dam, Near Phoenix, Will Be the Highest Multiple Arch Dam in the World

Will Impound 173,500 Acre Feet of Water in Lake 8 Miles Long and 2 Miles Wide for Irrigation of 40,000 Acres

WHEN completed, the Lake Pleasant Dam, Agua Fria project, now under construction near Phoenix, Arizona, will be the highest multiple arch dam in the world. From the stream bed to the parapet it will rise 170 feet, and the foundations are set 80 feet below the mean low water level of the stream across which it is built. The second highest multiple arch dam is located in California, near Palmdale, and is known as the Littlerock Dam. This structure was built under the supervision of J. G. Tripp, who has been retained by Carl Pleasant on the construction of the Lake Pleasant Dam.

The original reports and surveys were made on the entire Agua Fria project by John G. Bailhache, an engineer who has made a special study of Arizona conditions and the possibilities of the many irrigation projects. His report covered the natural water resources, the financial and engineering phases of the subsequent development, and it was upon his recommendation that the project became a fact. His report was concurred in by C. E. Griggs, chief engineer of the district, and additional checks were made before the bonds were sold to Stone & Webster Company of New York City.

Successfully Financed

The financing of the bonds for the Agua Fria project marked one of the most important steps in the agricultural development of Arizona, according to Carl Pleasant, the contractor who is building the dam and distribution works. "For the first time in the history of the state," said Mr. Pleasant, "the bonds underlying an important private irrigation development have been floated as one issue on the New York market—$3,325,000 worth of them. The bankers who underwrote the issue were brought to Arizona and taken over the entire project, and when they went home they were thoroughly sold. Heretofore irrigation securities have been handicapped in the New York market by the indifferent record of government reclamation projects farther north, where there is a short growing season. Consequently, Arizona irrigation bonds have been marketed piecemeal on the coast in small lots at a lower price and often with long delays between sales. With the connections that we have now established, there ought to be no more difficulties of that sort for future projects which have real value behind them."

The duty of the Lake Pleasant Dam is to impound 173,500 acre feet of water in a lake eight miles long and two miles wide for the irrigation of approximately 40,000 acres of land owned by the Beardsley Land and Investment Company on the west bank of the Agua Fria River. The average annual discharge of the river, as measured over a period of 15 years, is 254,000 acre feet, of which it is estimated that 140,000 acre feet will be diverted for irrigation. The

Lake Pleasant Dam, World's Highest Multiple Arch Dam.

remainder will waste into the spillway, at times of high floods.

Hydrographic Study

Twice in its known history, the river has risen to a peak discharge of more than 100,000 second feet, but the spillway gates will have a discharge capacity of 150,000 second feet. The plans call for 30 of them, each 23 feet wide by 16 feet high, set across a natural overflow channel situated about 750 feet northwest of the west end of the dam. No wastage is contemplated until the water behind the dam rises to a level within one foot from the parapet. Thus, the maximum storage capacity of the dam will always be realized as nearly as possible or, to put it another way, the money invested in the dam will be earning the greatest possible amount. The dam was designed to do a maximum amount of work for a minimum of material and investment.

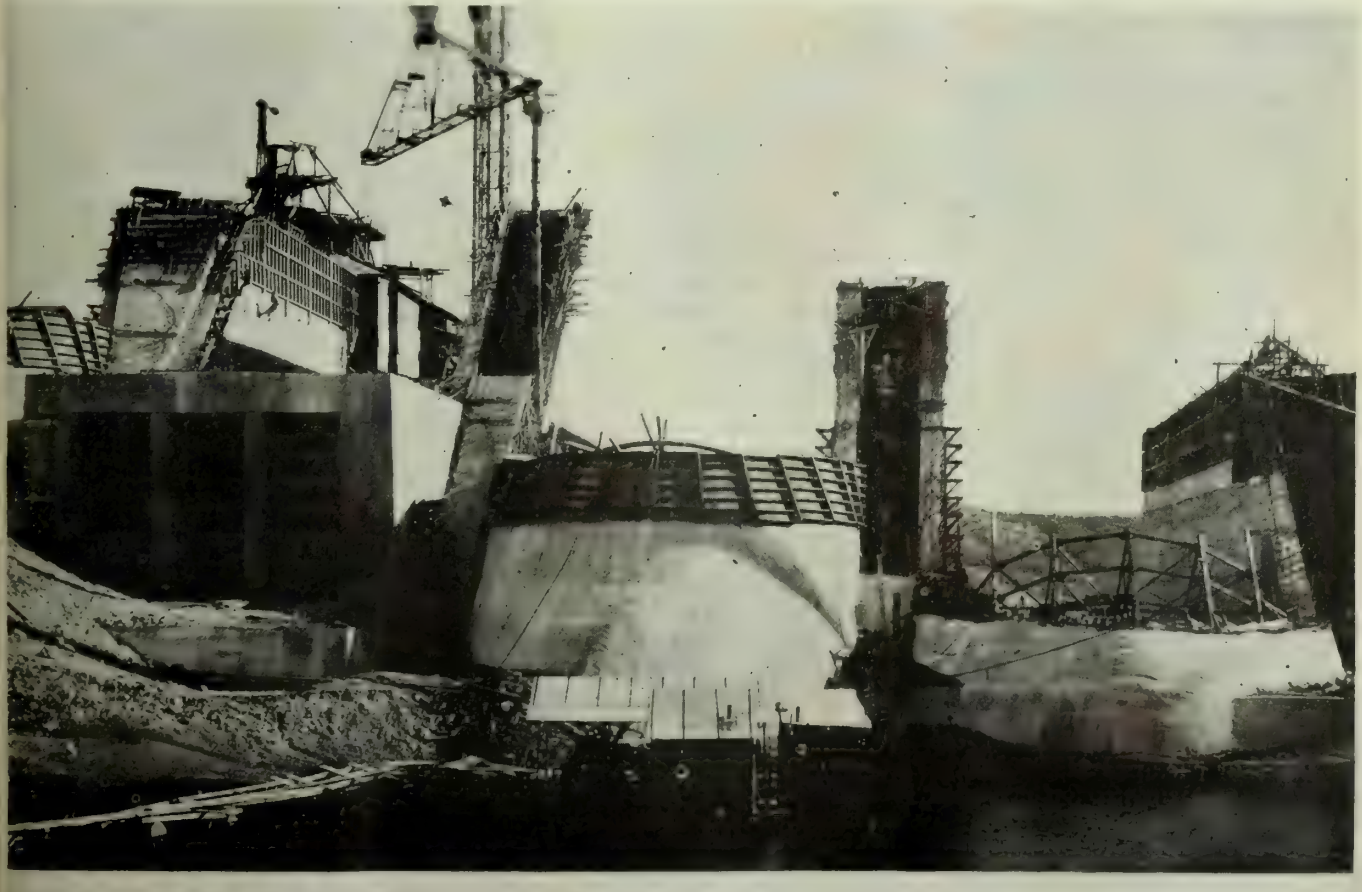
A multiple arch dam may be described as one relying for its strength, not on sheer mass and weight, but on the structural principles which enable an arch to absorb thrust on its crown and distribute overhead pressure through its piers and haunches to their supporting buttresses, bedded in the solid rock of the bottommost foundations.

The crown of the arch bulges upstream and slopes backward on its upstream face. The piers and haunches lie in the river bed, pointing down stream. The buttresses lie across the stream, and in turn transmit the stresses

(*Continued on Page 60*)

Facts About the Lake Pleasant Dam

Amount of money available for completion of entire project	$ 3,325,000
Date on which proceeds of bond issue became available	March 11, 1926
Storage capacity of dam, in acre feet	173,500
Amount of power to be generated annually in k. w. h.	23,000,000
Acres of land to be irrigated	40,000
January flow of river (maximum month) in acre feet	701,000
Maximum flood flow, in second feet	105,000
Minimum recorded flow, in second feet	0.60
Delivery capacity of diversion canal, in second feet	500
Length of main diversion canal, in miles	35
Aggregate length of lateral canals, in miles	60
Maximum height of main dam from bedrock, in linear feet	250
Maximum depth from stream bed to bedrock, in linear feet	80
Thickness of dam at bottom of longest buttress, in linear feet	253
Length of dam proper across crest, in linear feet	1,975
Length of spillway, approximate, in linear feet	750
Discharge capacity of spillway, through 30 gates, second feet	150,000
Bulk of dam, in cubic yards of concrete	75,000
Number sacks of cement used in mixing concrete	500,000
Weight of reinforcing steel used, in tons	1,200
Amount of excavation from river bed, in cubic yards	80,000
Amount of excavation for spillway, in cubic yards	30,000
Amount of excavation for masonry diversion dam	1,600
Amount of excavation for canal and laterals, in cubic yards	1,700,000
Total excavation for main dam and spillwy, in cubic yards	115,000
Grand total of all excavation, in cubic yards	1,900,000



Under Construction Near Phoenix, Arizona.

Bluewater-Toltec Project Presents Striking Example of Arch Type Dam

Structure is of Rather Bold Design Considering the Length of the Arch, 340 Feet, on a 175 Foot Radius; Height 97 Feet

By VERNON L. SULLIVAN
Consulting Engineer

Vernon L. Sullivan

AT the head of the seven-mile Bluewater Canyon in western New Mexico, where the Bluewater River and Cottonwood Creek join, lies one of the best natural reservoir sites in the Southwest.

More than thirty years ago the United States government was asked to have these lands within this reservoir site withdrawn for reservoir purposes, and two earth dams have since been constructed, both of which were washed out.

To the north of this reservoir and the proposed irrigated Bluewater Valley, lies the snow-capped and majestic Mt. Taylor, while to the south are the beautiful heavily-timbered Zuni mountains. The eastern slope of the latter provides the water-shed for this project.

The drainage area is 140 square miles and ranges from 7000 to over 9000 feet in elevation. The yearly run-off varies from 1547 acre feet in 1922 to 49,457 acre feet in 1925, and would, therefore, require a storage of 50,000 acre feet in order to provide carry-over of flood waters one year to another.

District Organized

The Bluewater-Toltec Irrigation District was organized under the laws of the state of New Mexico, by Reid, Hervey & Iden, attorneys at Albuquerque. A $350,000.00 bond issue was made to finance the construction of the irrigation works. The Chanslor-Canfield Midway Oil Company purchased $135,000.00 of the bonds and the contractors purchased the balance, all at par.

The lands to be irrigated and which go to make up the district consist of some ten thousand acres of level, irrigable lands located in the extreme north central part of Valencia County, some 100 miles west of Albuquerque and about 50 miles east of Gallup and lie on both sides of the main line of the Atchison, Topeka & Santa Fe Railroad and the Old Trails National Highway. The lands are of a silty, sandy loam and are fertile, well located at an elevation of approximately 6500 feet above sea level.

The soils are adapted to a wide range of crops and the climatic conditions permit of the successful growing of alfalfa, oats, wheat, barley, rye, fruits, celery, onions, beans, etc.

The owners of the lands to be irrigated will own all of the water, water rights, dams, reservoirs and canals.

The plans and specifications for the irrigation system as adopted by the district were designed by the writer and approved by J. P. Lippincott Company, of Los Angeles. Anderson Brothers, contractors, of El Paso, Texas, have the contract for the construction work.

Main Storage Dam

The main part of the irrigation works is the construction of the main storage dam at the head of the Bluewater Canyon, where the natural and flood waters are to be stored and released back into the canyon as needed for irrigation below, where they are again diverted from the stream at several points by low concrete diversion dams into various canals that convey the water to the lands to be irrigated. Thus the return waters from the irrigation of the upper lands is available and will be diverted on to the lands lower down.

The main storage dam is a single reinforced concrete arch across the canyon, with a 160-foot gravity end on the lower south side, in which are located two large syphonic spillways. The maximum height of the dam is 97 feet and the length of the arch is approximately 340 feet on a 175-foot radius. Two 30-inch cast iron high pressure gates provide duplicate outlets.

The reservoir capacity is approximately 53,000 acre feet.

On the opposite side of the canyon from the gravity section of the dam the walls rise some 150 feet above the top of the dam, and upon this bluff are located the construction power plant, crusher, roll-

(Continued on Page 96)

A view of the main storage dam, Bluewater-Toltec Irrigation Project, Valencia County, New Mexico. Construction details of unusual interest to the hydraulic engineer are apparent in this striking photograph.

Skagit River Project, Seattle's Big Development, Calls for Three Dams

Flexible Three-Plant Plan Will Enable City to Develop Current as Need Arises and as Money Becomes Available

By W. B. COAD

THE Pacific Northwest has seen many important hydraulic developments, but word recently has come from Seattle that there is to be built in the very near future a series of dams which promises to surpass any development of the past. This is the Skagit River project, a power development planned by the city of Seattle.

The Skagit River passes through a rugged, mountainous country, and has a drainage area of over 3000 square miles. The useful length of the river is approximately 125 miles. The contemplated project proposes to develop the upper third of the river affecting an area of nearly 1,200 square miles.

The area drained by this stream has a rather heavy precipitation, the average being 76 inches per annum. During the winter months the river flow, according to the records of the United States Geological Survey which cover a period of 16 years, averages 100,000 cubic feet per second; and during the summer months the average is 657 cubic feet per second. The mean flow for the period is recorded as 4,310 second feet.

Three Plans Considered

The original filings of the superintendent of lighting of the city of Seattle on the Skagit River power site were made in 1918, and contained three plans of development. The first plan involved the development of the entire 840,000 H.P. in one power house, using an 11-mile tunnel supplied by the Ruby Reservoir.

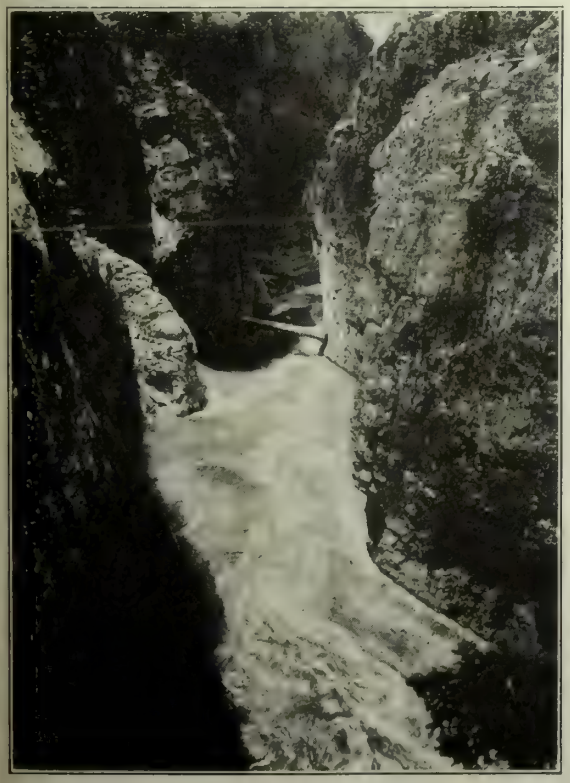
The second plan called for two plants, using a dam at the Gorge site, or at Diablo, to supply a lower power house, and introducing another power house near Diablo to be supplied from Ruby Dam through the proper tunnels.

The third plan, known as the three-plant plan, called for the erection of three separate dams. The Ruby Dam would be built, creating the Ruby Reservoir, impounding sufficient water to develop nearly 280,000 horsepower at a 50 per cent load factor, 475-foot head. Below Ruby Dam about six miles was to be located the Diablo Dam, located in the Diablo Canyon. This dam would have a head of 325 feet, and be capable of developing 240,000 horsepower. Practically the same operation would be repeated 4½ miles further down the river where a dam would be built near Gorge Creek, to be known as the Gorge Dam, having a potential power development of 320,000 horsepower, on a 50 per cent load factor.

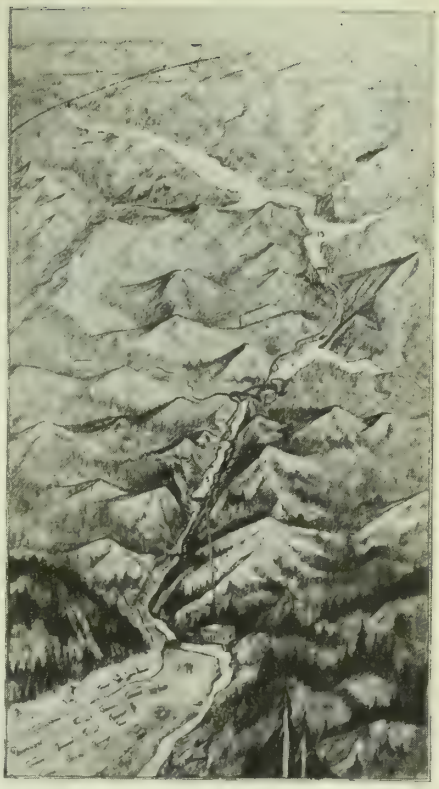
The one-plant plan at the time of filing was given merely to make the filing more complete. It was an impractical plan as it would develop all of the power of the Skagit River at once, an unwise proposition financially, even if it were sound otherwise. It would have required a long tunnel that could be avoided by using the three-plant plan.

The two-plant plan seemed to have considerable merit. It was much more flexible in that work could be done progressively as each step demonstrated the advisability of continuing. Labor costs were less and construction costs higher than under the three-plant plan. The main disadvantage lay in the long tunnel required from Ruby Dam to a central power house at Diablo Canyon.

The three-plant plan which has been adopted is the most flexible of all as it



Diablo Canyon, Seattle Municipal Water Project. The Diablo Dam will be built here and construction work is to start at once. The above view was taken from a suspension bridge which is 135 feet above the water.



BIRD'S EYE VIEW OF THE SKAGIT RIVER PROJECT

1. Newhalem power plant, 2000 h. p., used for construction purposes. 2. Gorge power house; ultimately 320,000 h. p., 54,000 h. p., now installed. 3. Two tunnels, 11,000 feet long, through granite. One tunnel now finished and in use, 20½ feet in diameter. 4. Dam near Gorge Creek; ultimately to be built to elevation 880 feet above sea level. (Now 770 feet elevation.) 5. Proposed Gorge Creek reservoir, 6,000 acre-feet. 6. Proposed Diablo power house, ultimately 240,000 h. p. 7. Tunnel serving Diablo power house; 1,700 feet long, 20½ feet diameter. 8. Diablo Dam; to be built in Diablo Canyon, to elevation of approximately 1200 feet. Construction of this dam is to begin during 1927. 9. Proposed Diablo reservoir, 90,000 acre-feet. 10. Proposed Ruby power house; ultimately 280,000 h. p. or more. 11. Tunnel serving Ruby power house. 12. Ruby Dam; to be about 525 feet high, set in solid granite. This dam will back up Skagit River 35 miles. 13. Ruby Reservoir; 3,000,000 acre-feet. Will conserve all run-off. 14. Canada-United States boundary line.

The EDITORIAL

MODERN Irrigation

Reg. U. S. Pat. Off.

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Vol. III JUNE, 1927 No. 6

Tomorrow's Water

AS THE WEST grows in population and industries, the deficiencies in water supply become increasingly evident. The settlement of new districts automatically calls for water supplies for those districts. Unfortunately, the total supply of water available in any locality is limited by nature and cannot be appreciably increased by any device of man. The most that can be done is to modify the distribution by means of storage reservoirs and canals or other means of conveyance.

Storage reservoirs must be located at points where streams from the watersheds tend to converge. But there are only just so many mountains in the west—only just so many possible pockets where water can be stored at any reasonable cost. As the lands now unused become more generally settled, there will undoubtedly come a day when all of these pockets must be utilized in order to conserve all the water possible. Careful surveys will have to be made to determine all our water resources and to learn where storage reservoirs can be constructed.

Much of the land that is being settled now and that will be settled during the next few decades is of poor quality. It cannot, under the best of natural conditions, be expected to produce valuable crops or return a large income. That being the case, it will be necessary to build dams for storing up water at the lowest possible cost consistent with safety in order that the construction charge per acre will not be prohibitive in comparison with the value of the land.

That the engineers of the western states realize this condition and are "on the job" is evidenced by the progress that has been made in various types of dams and in adapting them to their individual locations and the purpose they must serve. Mr. Noetzli in his article on different types of storage dams has given a comprehensive and authoritative review of what has been accomplished in this field and of what is yet to be done. While the science of dam engineering has made much progress during the past two or three decades, there is, as Mr. Noetzli points out, plenty of opportunity for further progress in the construction of safe and economical dams. The Stevenson Creek Test Dam investigation will do much to eliminate guess work, particularly in the construction of arch dams, and it is not unreasonable to hope that even relatively poor land can be supplied with water at a cost in keeping with the limited income that may be expected from those lands.

When Is an Engineer?

OPINIONS vary regarding the advisability, on the one hand, of making engineering a closed profession, and on the other, of fixing by legal license the professional status of every private practitioner and every engineer employed by others.

The leading proponents of license laws now countenance a laxness in requirements that enables any one calling himself an engineer to procure a license. Many of the states requiring engineers to be licensed make the tyro and the expert equal before the law, thus making the license meaningless and adding to the present confusion in the mind of the layman. A few states, of course, require examinations and records that expose the real engineering status of the licensee. But many engineers complain that unqualified men assume the title and often, through ignorance of the employer or design of public officials, attain the place of qualified men to the distinct harm of the profession. They assert that the only way to prevent the unqualified from assuming the name and claiming the competence is by closing the profession, as has been done in law and medicine.

On the other hand, it is argued, and with reason, that the creative mind is an inheritance and not a product of the classroom; that making engineering a closed profession will bar from service many good men whose natural ability and whose training in certain well-defined lines fit them well for limited service. If licenses are graded, much as the membership in the founder societies is graded, if they show the principal divisions of engineering in which the licensee is authorized to practice, if they are granted only after a suitable examination and are uniform in requirement and reciprocally accepted

POINT *Of* VIEW

among the states, the license will improve the status of the profession without placing undue hardship on its members.

"All Modern Conveniences"

THE ordinary conception of a construction camp can hardly be applied to the camp that has been erected to house men and machinery at the Coolidge Dam site in Arizona. Workers on this project, we learn from the progress report of the undertaking printed on another page in this issue, though far from centers of population, enjoy "all the comforts of home"—and then some in the case of much of the labor employed on the project.

The camp illustrates what large contractors are doing in this day and age for the welfare and comfort of the worker in his off hours. For the married workers, individual bungalows equipped with running water, bath rooms and real kitchens; and for single men, large roomy bunk houses having all the conveniences of a city hotel are features of this camp. The kitchen is full of labor-saving electrical devices, including a modern ice plant; and there is a soft drink emporium. The modern aspect of the camp is noticable also in the business end of the camp—the machine shops and blacksmith shop, where practically all of the repair work on equipment will be taken care of.

Illustrations on pages 28 and 29, obtained by this journal through the courtesy of Atkinson, Kier Bros., Spicer Company the contractors, will give the reader some idea of the physical aspects of the camp at this writing. Needless to say, the contractors consider the money spent for the comfort of the worker a good investment. They do not pose as philanthropists. They firmly believe that the importance of the worker's good morale is paramount on any construction job in an isolated location. In the months to come the worker will demonstrate without question that the investment pays.

San Gabriel

THE engineer as well as the laymen must thrill from a reading of the plans for the construction of the San Gabriel Dam, Los Angeles County's great flood control project, and from the ensuing realization that this structure of concrete will be the greatest thing of its kind ever erected by man.

Someone with a flair for figures has drawn a few interesting comparisons that bring to mind rather vividly the hugeness of this Southern California project. The concrete in the dam will, we learn, be nearly four times that of any dam ever constructed and will exceed the combined concrete in Arrow Rock, Exchequer, Elephant Butte, New Croton, Roosevelt, Don Pedro and Melones Dams.

It is rather surprising to learn, too, that the San Gabriel Dam will contain nearly five times the concrete that is contained in the Assouan Dam in Egypt, and will lack only thirty feet of the height of the largest pyramid in Egypt.

The excavation alone, we are told, will require the removal of over a million and a quarter yards of earth and rock or sufficient to excavate an irrigation canal 20 feet bottom, 10 feet deep and 25 miles long. To pour the gigantic volume of concrete will take over three years at three times the present record of pouring. To accomplish all this will necessitate the construction of a plant costing nearly two million dollars and will require a camp of 1,500 or more men. The works will resemble a good sized town. The estimated cost of the dam is in excess of $25,000,000.

The eyes of the hydraulic engineering world will be on this great project during its construction. Many will come from great distances to watch its progress and take, as it were, a post graduate course in dam construction. The best minds in the profession are engaged in the work, the accomplishment of which will be another milestone in hydraulic dam development.

Those who can not actually witness any phase of the construction of the dam will be assured of periodical progress reports and pictures in the columns of MODERN IRRIGATION. This journal is fortunate in being particularly well situated geographically to "cover" this big "story" in the field of hydraulics and its engineering staff members will give first hand reports of the work as it progresses.

California in 1928

THE next annual convention of the American Water Works Association will be held in the west as a result of action taken at the recent annual meeting held in Chicago. California has been chosen for the next meeting and either San Francisco or Los Angeles will be the favored city.

This announcement comes as good news to members of the western waterworks fraternity, few of whom find it possible to make the long jump to the east of the Rockies for the convention. This will be an opportunity for the western industry to come together with men from every other part of the country and benefit as one always does from the program of papers and the interchange of ideas in the ensuing discussions.

Western waterworks men can fill the bill when its comes to acting as hosts if the conventions of the California Section may be taken as a criterion. There are several important factors contributing to the success of such a gathering, not the least of which is a happy faculty on the part of the arrangements and entertainment committees in making visitors feel at home in a strange city and among unfamiliar faces. The natural diffidence of many who come alone must be overcome and these visitors must be made to fell that they have had an enjoyable time, as well as profitable experience from the standpoint of acquisition of new knowledge. We believe the western fraternity can put on a good convention and we predict a big success for the 1928 meeting.

Salt River Valley's $25,000,000 Investment Has Reclaimed Half Million Acres of Desert

Success of Big Arizona Development Based on Sound Financing and Competent Engineering; Power Contracts Bring in Big Sums

By ELLIS WALES

THE 40,300-horsepower hydro-electric plant of the Salt River Valley Water Users' Association of Phoenix, Ariz., went into service in April and when the final touches are made on the parapet and approaches of Horse Mesa dam, into whose base it was built, the project will be complete. The great powerhouse, several stories high, the size of some metropolitan office buildings, is built at the base of the dam wall as a part of the whole structure, the huge wall of masonry rising above it to 305 feet.

The Horse Mesa dam is the next below the famous Roosevelt dam and lake, and will soon form what will be known as Apache Lake, appropriate to Apache Trail, the great scenic highway running from Phoenix to Roosevelt Lake. Further on is an account of how the Horse Mesa will form a part of one of the most remarkable chains of lakes and dams in the world. Roosevelt dam reservoir has many times greater volume in acre feet, but the Horse Mesa, with but 245,000 acre feet, will develop almost double the horsepower. The cost of the dam was $4,743,000.

Power Developed

With a powerhouse at the base of every dam insuring electric power for every purpose, the development has placed hundreds of thousands of acres of rich, but barren, desert land into generous production. As fast as a dam is built a great area of thousands of acres is opened to irrigation. As these lands are opened to cultivation and homes the railroads advance a pace and throw out their ribbons of steel into territory once a forest of Sahuaro cacti and sagebrush.

The process and mechanics of building dams are said to have reached the acme in mechanical and "few-men" masonry construction in the Horse Mesa dam, now approaching completion. On the field they dub it the "machine-made dam" and it warrants such a description. Nearly 7000 Arizona farmers have been waiting eagerly for this giant to be completed because they have seen where one dollar is doing the work of two.

As the wall came upward a small lake of water was ponded back of the dam, and according to the secretary of the association, this water is passed through the dam by means of three eight-foot penstocks, which connect with the three 15,000 horsepower generating units in the powerhouse. Gravel is dug from the river bed by floating derricks operating clamshell buckets, dumping on to scows. These are towed to the foot of an inclined double-track trestle, which leads from the water's edge up to the base of the hoisting tower and mixing plant 300 feet above the river. The gravel dump cars are raised by steel cable, a full car going up as an empty one comes down.

An up-stream view of the Roosevelt Dam, which supplies power for the Salt River Valley Project, which is, perhaps, the most conspicuous example of how power and irrigation may be made to work together for reclaimed territory.

Modern Construction

Two marine tugs, forty feet long, tow the gravel scows from the beds two miles above the dam. All hoists, mixers and devices are operated electrically by the association's own power and remarkably few men are required to operate the outfits. From the self-dumping cars and automatically washed gravel to the mixed concrete, the great mass is discharged into a twenty-inch steel-lined chute, which is moved along the wall by cable suspension, through which it is poured for 800 feet of curves to its final resting place in the dam wall.

The amount of cement required for each cubic yard of concrete has been three and nine-tenths sacks, due to accuracy of mixture and the expert use of rocks up to six inches in diameter in the concrete. The cost for concrete in place has been around $6 a yard. The cost of the gravel at the mixing bins has been 60 cents.

The dramatic feature of the Salt River project in power development as well as enormous water storage, is the process of constructing a series of the largest dams, Roosevelt, Horse Mesa, Mormon Flat, Stewart Mountain and Granite Reef and Joint Head diversion dams, in a perfect, connected chain, dropping down from the Roosevelt dam, high-water level at 2142.1 feet elevation, to 1116.5 feet elevation. Joint Head and Granite Reef waters will be brought to the base of the big power canal, the latter tapping the Stewart Mountain dam at an elevation of 1475 feet; the waters of the latter will be brought in contact with the base of Mormon Flat dam and this reservoir will back up to the base of Horse Mesa dam, and the big fourteen-mile-long Horse Mesa "lake" will be flush with the base of the gigantic Roosevelet dam, thus making a chain of immense artificial lakes totalling about seventy-eight miles.

Today, the deep-set Canyon Lake, the reservoir made by the Mormon Flat dam, nine miles long, bordered wholly by towering cliffs, is one of the most beautiful bodies of water in the world. Former Governor Frank L. Lowden of Illinois, a recent visitor, told me he thought it the most attractive place in Western America. The lake now forming by the Horse Mesa dam will be called Apache Lake. This lake will be able to reach the base of the Roosevelt dam through the great height of the Horse Mesa dam, the highest in the chain, which is 305 feet from foundation to parapet top.

50-Mile Inland Waterway

One of the chief engineers of the project having declared its practicability, an application has already been received to run a line of excursion or guest launches and canoes throughout the full length of the "chain" of waterways. The company proposes to sail the full length of each

(*Continued on Page 82*)

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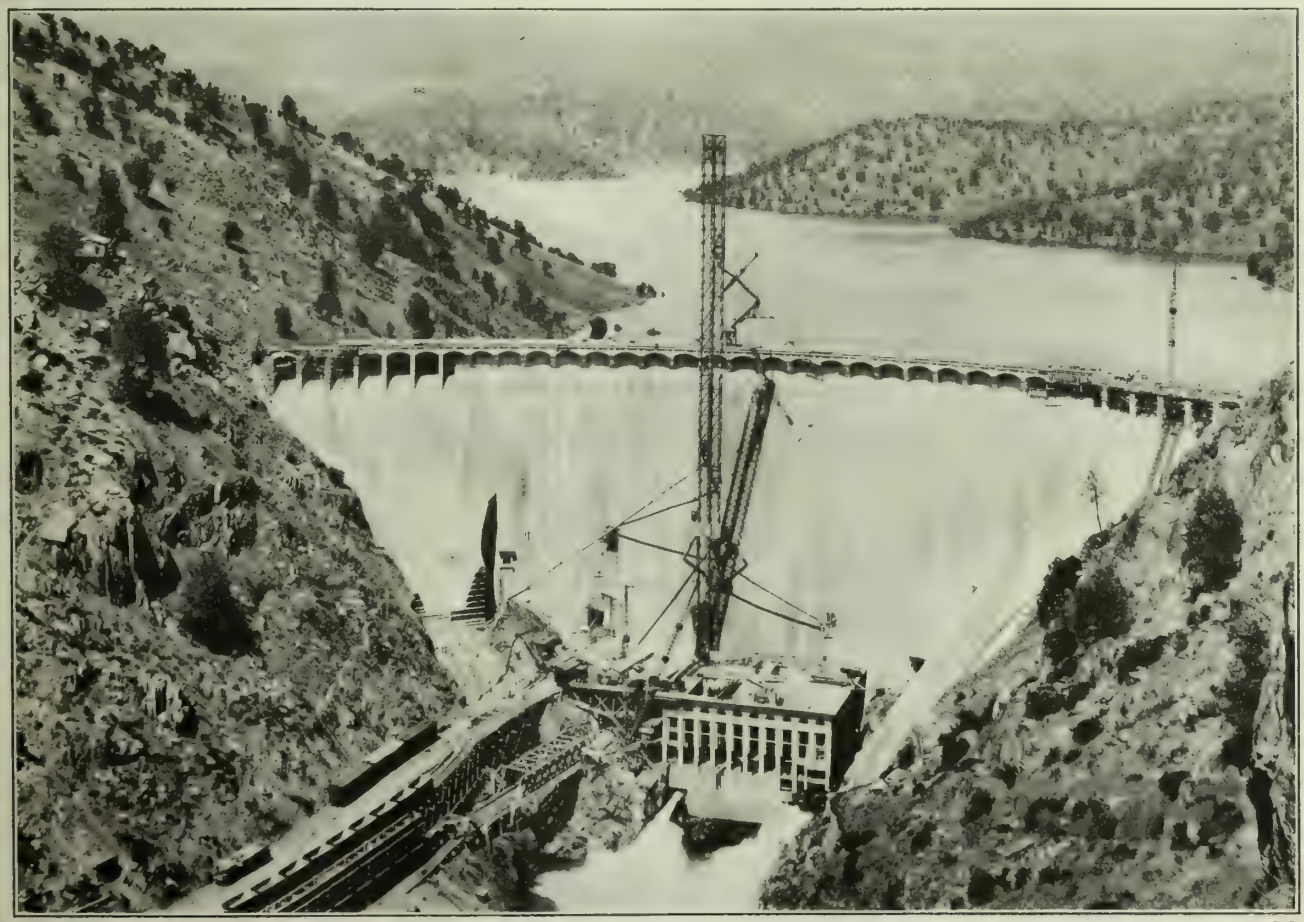

Exchequer Dam, on Merced River, recently completed. Bent Brothers, Inc., Contractors

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Concrete to Be Poured Soon for Gibson Dam, Sun River Project's Arch Type Structure

Will Have a Crest Length of 900 Feet and Maximum Height of 195 Feet; Located 80 Miles West of Great Falls Montana

By BYRUM W. STEELE
Engineer

THE Gibson Dam, contract for the construction of which has been awarded to the Utah Construction Co., is now under construction. The dam site is located about 80 miles west of Great Falls, Mont., on the North Fork of Sun River, a tributary to the Missouri River.

The dam will be of the massive concrete arch type. It will have a crest length of approximately 900 feet and a maximum height of 195 feet. Augusta is the nearest railroad point and is the terminus of the Great Northern Railway branch line from Great Falls. The distance from Augusta to the dam site is approximately 23 miles, the greater part of the distance being over rolling country. About 3 miles below Gibson Dam site is the Sun River diversion dam, which is the point of diversion of all water for the 90,000 acres of the irrigable land of the Sun River project lying north of Sun River.

In order to obtain electric power for the operations connected with the construction of the dam, the contractor has built about 28 miles of transmission line from the Montana Light & Power Co.'s line to Augusta.

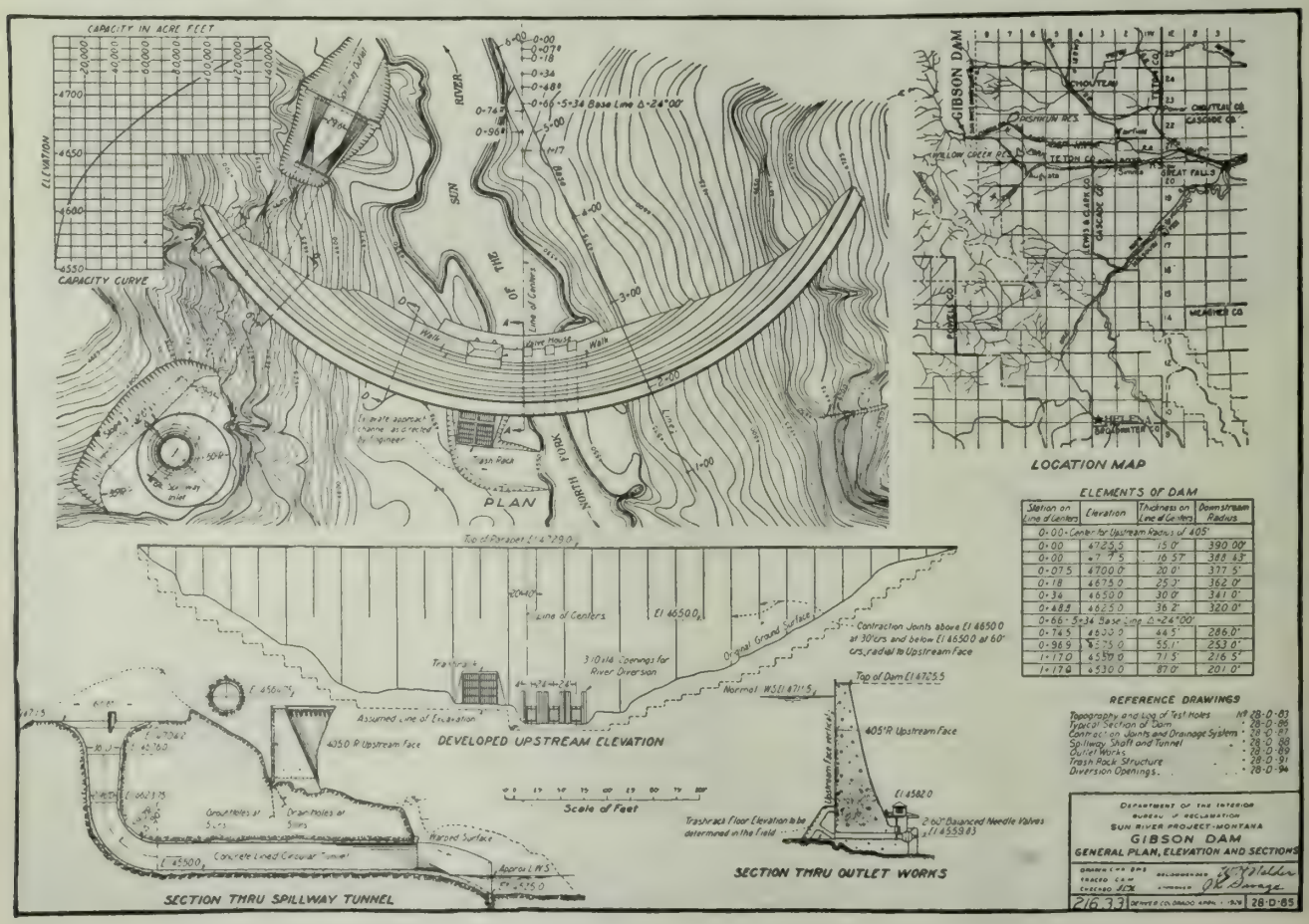
Work Started December, 1926

Excavations for the base of the dam and the spillway were started as soon as the electric power was available, early in December, 1926. The rock to be excavated is a fine-grained limestone, which near the surface is badly weathered. The construction program contemplates completing all excavation for the dam and spillway by August, 1927, after which time concrete will be poured as far into the winter as the weather will permit. During the winter of 1927-28 it is contemplated that work at the dam will be largely suspended, since it would not be economical to place concrete during the winter months in this climate.

The spillway is located in the north abutment and provides for a discharge of 50,000 second-feet by means of an uncontrolled circular lip discharging into a vertical shaft and in turn into a horizontal tunnel leading to the river level below the dam. Provision has been made in the design so that drum gates may be installed on the spillway lip at some later date, thus increasing the storage capacity of the reservoir from 90,000 to 105,000 acre-feet without raising the crest of the dam above the elevation provided for in the present contract. The spillway will be concrete lined throughout, the intake, outlet, and shaft lining being reinforced. The horizontal or tunnel portion of the spillway will be lined with plain concrete.

River diversion while the base of the

(*Continued on Page 95*)



Station on Line of Centers	Elevation	Thickness on Line of Centers	Downstream Radius
0+00 - Center for Upstream Radius of 405'			
0+00	4725.5	15.0'	390.00'
0+00	4717.5	16.57'	388.43'
0+07.5	4700.0	20.0'	377.5'
0+18	4675.0	25.3'	362.0'
0+36	4650.0	30.9'	341.0'
0+88.5	4625.0	36.2'	320.0'
0+66.5+34 Base Line Δ=24°00'			
0+74.5	4650.0	44.5'	286.0'
0+96.9	4675.0	55.1'	253.0'
1+17.0	4559.0	71.5'	216.5'
1+17.0	4530.0	87.0'	201.0'

Intake Tower and Lake From West End of Dam

Downstream Slope of Dam West Side of Canon

Earth Dam, Hydraulic Fill

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Propose Hydraulic Fill Dam to Control Water Flow in Santa Ana Canyon

Orange County, California, Voters Asked to Decide Fate of $5,000,000 Water Conservation Plan; Lippincott Makes Survey

CENTERING around a check dam across the river at the head of the Santa Ana Canyon, a water conservation project will be submitted to the voters of Orange County, California, according to a statement from the office of the County Supervisors. Following a survey by J. B. Lippincott, consulting engineer, the state engineer's office has finished a thorough investigation and has declared the proposed program to be feasible.

It is estimated by Mr. Lippincott that a check dam in the Santa Ana River near the station of Prado will net the people of Orange County an annual saving in cash of $535,000. The Board of Supervisors will ask the people of Orange County to vote an issue of bonds in the amount of $5,000,000 to complete the work.

Supporting their contention that action toward the conservation of water in the Santa Ana basin is necessary, the County Supervisors point out that the area of good agricultural land in Orange County is 220,000 acres, of which 165,000 acres now are cultivated, and 120,000 acres of which now are irrigated. The irrigated area has increased 3.5 times in the last thirty-five years. With water levels in wells over the county dropping, as the newly developed lands demand water, it is declared to be imperative that all available water be conserved until a new source of water can be secured or developed, or that the further extension of irrigation in the county cease. With this serious problem in mind, the County Supervisors have long sought a practical solution.

Above: Map showing location of proposed water conservation project in the Santa Ana basin, Los Angeles County, California. Below: Rough sketch of proposed hydraulic fill dam.

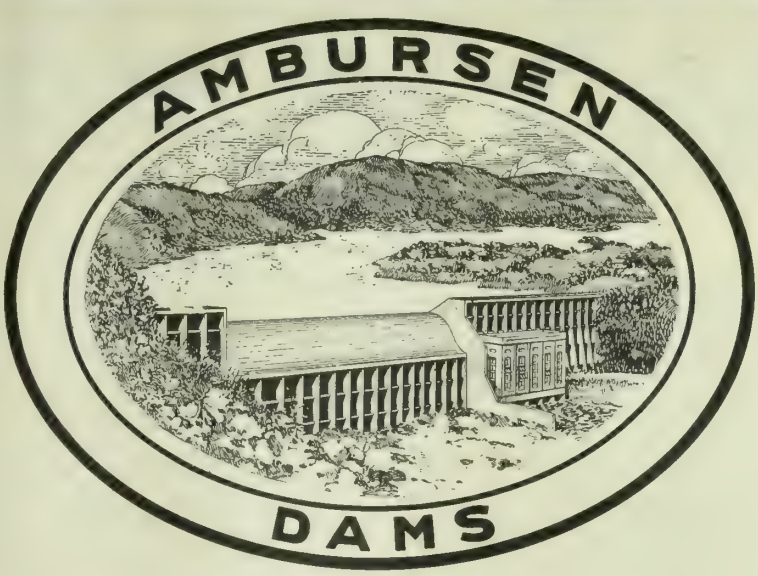
It is shown by the report of J. B. Lippincott that the consumption of water in Orange County is now 39,499 acre feet per year more than the seasonal supply.

20,000 Acre Feet Wasted

It is shown that the seasonal supply in Orange County is 208,501 acre feet. Estimaters agree that 20,000 acre feet are wasted into the sea every average year. Evaporation losses are estimated at 60,000 acre feet. This leaves a net available supply of 128,501 acre feet. The actual water used on the 120,000 irrigated acres is given as 168,000 acre feet. Thus the overdraft of 39,499 acre feet is arrived at.

The location of a large dam at Prado, or Rincon, as the station is given on the railroad map, just above the upper end of the Santa Ana Canyon in Riverside County, is advised. The dam would be seventy feet in height. Above the dam site is a very large natural basin. With a maximum depth of seventy feet of water at the dam it is shown that 174,000 acre feet of storage can be obtained. The tributary drainage area is given as 1485 square miles. The plan proposed is for a hydraulic-fill dam at a point above the Santa Fe Railroad crossing for this storage capacity. It is explained by the County Supervisors,

(*Cont. on Page 98*)



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Raising of the Big Meadows Dam, Plumas County, Cal., Remarkable Engineering Feat

Structure Elevated 45 Feet to Provide Additional Storage and Thus Prevent Repetition of Situation Created by Recent Dry Year

By D. R. WARREN
Consulting Engineer, San Francisco

LAKE ALMANOR, a reservoir in the head waters of the North Fork of the Feather River, has a surface area of 47 square miles and a capacity of 1,308,385 acre feet. This artificial lake at an elevation of 4500 feet above the ocean is in Plumas county, California, approximately 170 miles north and 45 miles east of San Francisco. This lake is the property of the Great Western Power Company of California, a subsidiary of the North American Company, and through them is associated with the San Joaquin Light and Power Company.

The watersheds for the hydroelectric plants of the two companies and the seasonal demands for electrical power by each have proven a mutual benefit by the interchanging of electrical power.

This lake with its immense storage capacity enables the Great Western Power Co. to so equalize the flow of the North Fork of the Feather River that they are assured a continuity of hydro power even during years similar to the most severe periods of drought on record. The waters from the reservoir guarantee an even flow of the otherwise unregulated lower river. The water, with an available effective head of 3808 feet, will ultimately pass through ten power houses, having a combined capacity of approximately 1,000,000 horsepower.

More Uniform Steam Flow

In the 500 square mile watershed of Lake Almanor are the lava regions of the High Sierras near Mount Lassen, in which are found many exceedingly large flowing springs. These springs together with the porosity and sponge-like nature of this area regulate the run-off, making the stream flow more uniform than most California streams.

The dam is situated at the southerly end of what was formerly known as Big Meadows, just at the start of the canyon proper.

The old dam, designed by the late Julius Howell and built under his supervision in 1913, was a hydraulic fill. Owing to the porous nature of the lava it was essential that the path of seepage be made as long as possible. The puddle core was extended upstream through the rock toe along the bed of the stream for several hundred feet, thereby effectually sealing up this area. Sixty-foot interlocking steel sheet pilings were driven into the lava boulder formation and left projecting into the puddle core. Thirteen years of use have demonstrated the thorough effectiveness of this cut-off. This dam was raised to an elevation of 4470 feet in 1914 with the spillway lip at elevation 4451. Flashboards were later installed in this spillway, bringing the reservoir to elevation 4455 with a storage of 293,816 acre feet.

The serious dry spell culminating in 1924, one of the dryest years on record in California, emphasized the necessity for more storage, and by the end of 1924 studies had been made and plans decided on for raising the existing dam to elevation 4515 with a spillway crest at elevation 4500.

The puddle core and the cut-off of the old dam had been so effective that the engineers decided to connect the puddle core of the new dam to that of the old one.

Work Started

On March 20, 1925, a contract was entered into with the Foundation Company of New York for the construction of the new dam with controls. Work was promptly started and a well-equipped camp established. The new dam site was carefully cleared and all loose surface material was hydraulicked off.

A spur railroad track was extended to the job from a near-by logging road of the Red River Lumber Company. Over this track all heavy equipment and steel were brought to the construction site, while smaller and lighter materials and supplies shipped from the Pacific Coast were trucked from Crescent Mills to the dam site, a distance of seventeen mile.s. A small sawmill was built and two million board feet of lumber was cut from the borrow pit clearing and used for construction.

The new dam is a structure complete in itself, the puddle core extending through its own upstream rock toe connecting with the top of that of the old dam. That the adjacent banks and the area in front of the spillway might be more water-tight the main puddle of the dam was extended as a blanket over these areas.

There are two outlets from this lake: one is situated at Prattville, seven miles from the dam and leads through a tunnel to Butte Valley Reservoir (55,000 acre feet capacity), thence and by another tunnel and penstock to the Caribour Power House (66,000 K. V. A. installed, ultimately 132,000 K. V. A.); the second outlet is an intake tower or conduit under the dam and is used for emergency in passing water around Caribou Power House to the Big Bend Power House.

River Channel Deepened

Provisions had to be made for a 2400-second-foot discharge at any time during the construction of the dam. To provide for this the river channel was deepened with two gas shovels and a culvert puilt under the downstream rock toe. This permitted the building of the downstream rock toe from the spillway excavation while the new conduit was being built.

The new conduit had a slightly larger section than the old one to which it is connected. To enable a rapid connection to be made between the conduits a steel transition section was made that would serve as an inside form for the connecting section and would be strong enough of itself to withstand the required discharge of 2400 second feet. This was so arranged that it took but 37 hours to put it in place and concreting continued without hindrance from the conduit discharge.

The new conduit was of the horseshoe type with curved invert, heavily reinforced to care for the most severe conditions of loading during the construction of the dam. The outlet structure of the new conduit maintains water in the conduit for its entire length, thus forming a water cushion at the bottom of the intake tower and thus greatly reducing the erosive action of continued discharge of large volumes of water.

Intake Tower Described

The original intake tower was of circular section having nine equally spaced

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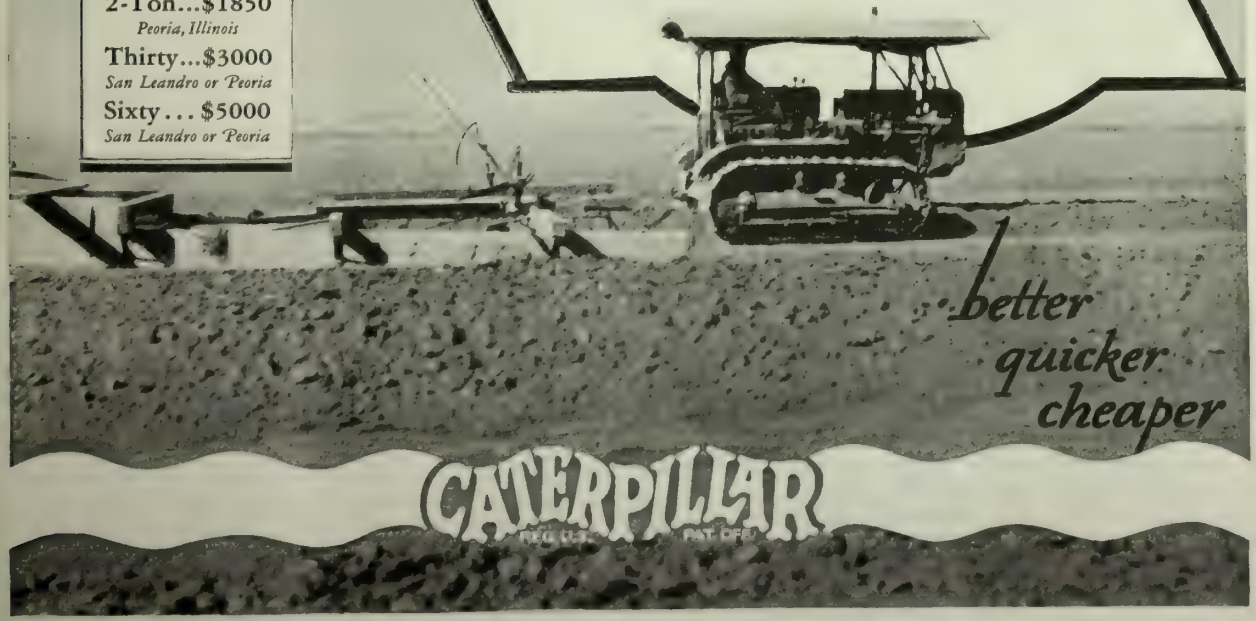

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radiating buttresses, between which were located the regulating gates with screnes. When the new dam was built this tower with an elevation of 4465 was raised to 4515. In order that the gates might be used under high heads two additional gates were installed at elevation 4656. The electrically operating mechanism for raising the gates is housed in a concrete structure at the top of the tower. Between the south buttresses of the tower are stilling wells with accurately calibrated gauges that the water surface may be accurately determined. The spillway with a crest length of 500 feet and a depth of 15 feet is entirely of reinformed concrete. In its hydraulic design every effort was made that the flow of water might be as uniform and orderly as possible. At a depth of 8 feet the rated capacity is in excess of 42,000 second feet and the added capacity of this eight feet in the lake represents 240,000 acre feet or nearly 120,000 second feet for one day. This means a storm twenty times in excess of any on record and a storm to overcome the additional seven feet of free board is beyond any conceivable happening.

The flatter portion of the spillway floor was placed over a layer of gravel while the steeper slope was protected by a system of tile drains. The spillway of reinforced concrete has all construction joints broken by metal strips. This floor slab extends into a 10-foot cut-off trench at the spillway lip over which the puddle blanket at the approach extends. This puddle blanket is covered with a layer of sand and gravel while additional protection from high velocities near the lip is made by a strip of riprap 100 feet wide. All the spillway walls have a frost protecting coat of gunite ¾ inch thick.

Hydraulicking

The hydraulic borrow pits situated southwest from the dam were very carefully explored by jetting, chain drilling, and open pits so that the elevations and nature of the material available for the dam were definitely ascertained. This expenditure for exploration work was well justified, for the available materials were within a close amount of the dam volume.

From these data a well-studied plan was laid out for the different flume lines so that the correct amounts and most advantageous materials were used for the different portions of the dam.

The pumping plant situated near the conduit outlet consisted of six Byron Jackson centrifugal pumps size 10"x20", direct connected to 300 H.P. 2200-volt General Electric induction motors, each motor having its own switchboard with ammeters and circuit breakers. The pumps were operated in three groups of two in series. This pumping plant was capable of furnishing 24 second feet against a 540-foot head. Each pumping unit was connected to automatic recording flow meters which gave an excellent record of performance. A total of 21,869,512 cubic yards of water were pumped and a total of 13,436,826 K.W.H. of electrical power consumed.

The flumes and pit areas were so operated that the hydraulic operations were practically continuous. Two flumes and two pits were nearly always available for discharging on the dam. These flumes carried on wooden trestles were of the metal type, egg shaped, with removable liners.

Beaching Operations

Depositing of hydraulicked material started from the downstream toe, all fine clay being discharged downstream through effluent pipes until the beach of sand and gravel reached the downstream toe of the old dam. When this point was reached, two effluent pumps, placed on skidways on the downstream slope of the old dam, were used to discharge the effluent at the areas to be blanketed. This beaching operation continued until a subbase of coarse porous hydraulic fill was deposited to the elevation of the top of the conduit; from then on a puddle pool was maintained extending from the center of the new dam to the toe of the old dam, the puddle material passing through the stability upstream rock toe of the new dam and thoroughly filling the voids therein. This puddle pool was maintained until it had reached an average depth of 15 feet. Hydraulic operations were then suspended for three weeks and the puddle given a chance to settle. On resumption of hydraulicking this puddle area between the upstream toe of the new dam and the old dam was covered with sand and gravel deposited from a pipeline, connected to a flume and floated over this area on a pontoon bridge. Thus the puddle was consolidated until it would directly support the flume trestles. Flumes were laid thereon and discharging carried on from the center of the area and downstream. At all times a puddle area was maintained in contact with the old dam, canyon sides and extending to the puddle core in the new dam through its upstream rock toe.

The top of the old dam was removed by shovel excavation and the original puddle core exposed. The new puddle pool was carried up until good contact was made with this original puddle core. In this way a thick impervious puddle membrane is carried continuous from the old dam core through the new dam.

The upstream face of the new dam above the elevation of the old dam 4470 has a 3:1 slope protecting the riprap hand-placed but not rubble-laid.

Aggregates for concrete were produced at a gravel plant 12 miles from the job, with exception of that used in the conduit which was shipped in from Marysville, as the gravel plant was not yet in operation. The concrete mix was determined by sieve analyses to give the densest 1:2:4 concrete. Varying percentages of celite for concrete were used with satisfactory results.

This dam was completed in January, 1927, and is a credit to all parties interested in its culmination.

Montana Has Economic Parley

The Bureau of Reclamation, Department of the Interior, has announced that a farm economic conference for irrigated land was recently held at Sidney, on the Lower Yellowstone Project, Montana, under the auspices of the Montana State College of Agriculture and Mechanical Arts. Production costs and returns realized from the various crops were studied.

"The resulting recommendations," the Bureau said, "cannot fail to improve the agricultural practices on the project. The results of the conference will be published in pamphlet form and made available for all water users.

District Asks New Weir

The board of directors of the Imperial Irrigation District at its May meeting authorized the secretary and chief engineer to make applications with the war department for the installation of a new weir in the Colorado river for the 1927-28 season. The weir was blown out during the flood early this year. It will not be replaced until low water makes it necessary to divert enough to supply the valley, but the contract with the war department is one that must be renewed each year. An indemnity bond must also be filed at Yuma to protect that city from possibility of flood due to the weir which might cause an overflow in time of high water.

The Hydraulic Society has dropped the terms right hand and left hand as applying to pump rotation and now use the terms clockwise and counter clockwise. As rapidly as changes are made in bulletins and data sheets the terms right hand will be changed to clockwise and the designation left hand will be changed to counter clockwise. The direction of rotation is, of course, determined when standing at the pump end of a unit and facing the pump.

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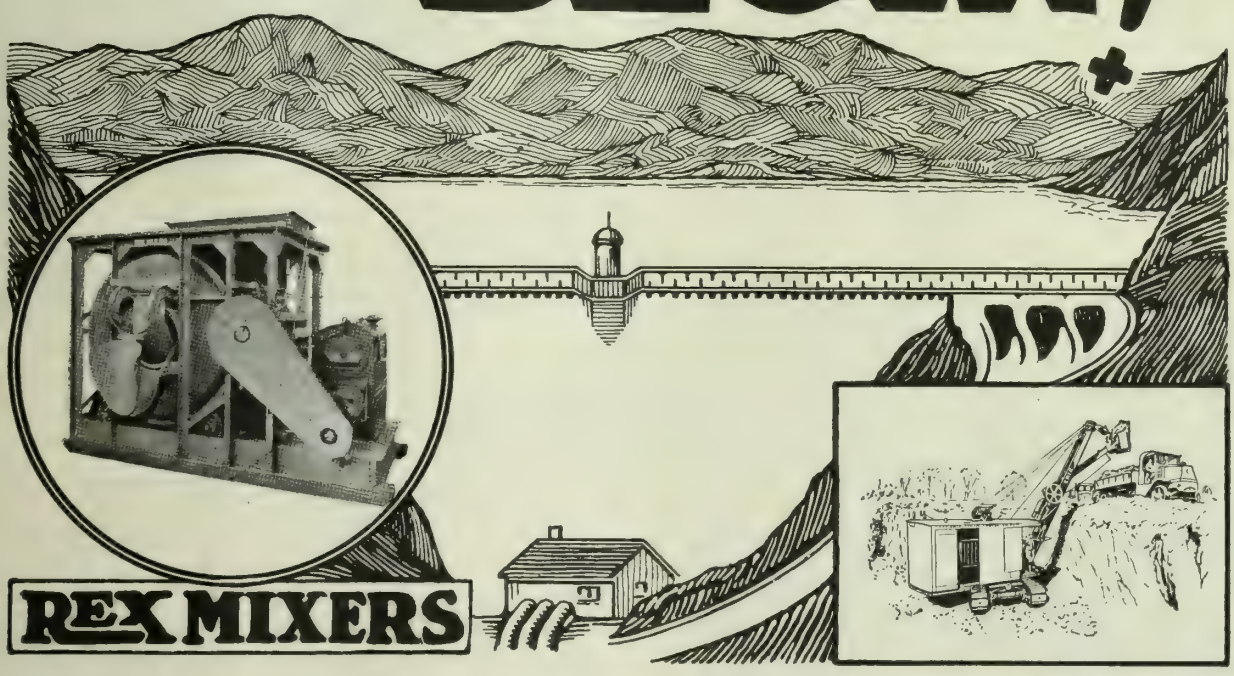

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Stony Gorge Dam on the Orland Project Is Example of the Ambursen Type of Structure

Is Considered the Best Construction to Withstand Settlement or Movement Along the Line of a Fault

By BYRUM W. STEELE

THE Stony Gorge Dam, now under construction on the Orland project in California, will be of reinforced concrete. It will have an overall length of about 900 feet and a maximum height above the stream bed of about 120 feet. It will be of the Ambursen type, the essential features of which are an impervious inclined upstream face designed as a flat slab and supported by concrete buttresses. The upstream face is placed at an angle of approximately 45° with the horizontal so that the weight of the water impounded and lying above the dam adds to its stability. The general plan, elevation, and sections of the dam are shown on the accompanying drawing.

The contract for the construction of the dam, bids for which under specifications No. 449 were received on August 18, 1926, has been awarded to the Ambursen Construction Co. of New York and San Francisco. This dam is located on Stony Creek about 40 miles southwest of the town of Orland. Stony Creek, at the north end of the reservoir site, swings westward, cutting through a low range of hills which owe their existence to the occurrence of a series of sandstones and shales. Where Stony Creek breaks through this ridge is marked by a fault line, running parallel to the creek, the presence of which is largely responsible for the type of dam which has been selected.

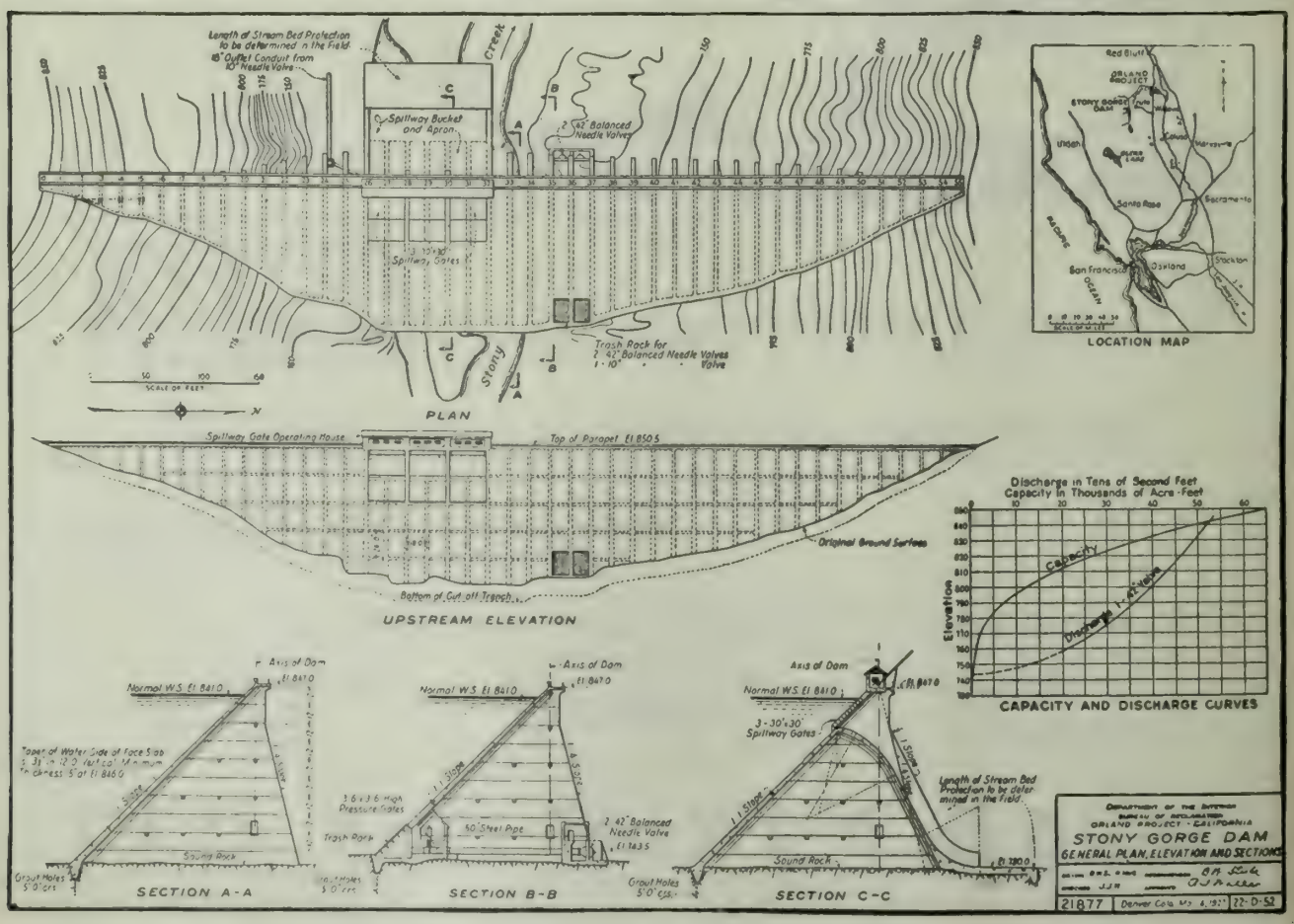
The floor of the reservoir area is largely of impervious shale, the bedding planes of the shales and sandstones being tipped about 60° off the horizontal and toward the east. Thus the floor of the reservoir area and the dam site are rendered highly impervious to water as the seepage from the reservoir must travel perpendicular to the bedding planes except at the upper and lower extremities of the reservoir.

Ambursen Type Dam

Various types of dams were considered for this location and the Ambursen was finally chosen as the type best adapted to withstand settlement or movement along the line of the fault. A multiple arch would probably cost a little less to build, but owing to spillway complications and the fact that any settlement or movement might prove disastrous, it was decided to discard the multiple arch type.

Spillway capacity for a flood of 30,000 second-feet is provided by three 30 by 30 feet stony gates which are mounted on the upstream face of the dam. These gates are of the overflow type and are operated by means of stems connected to electrically operated hoists located in the spillway gate house on the top of the dam.

(Continued on Page 99)



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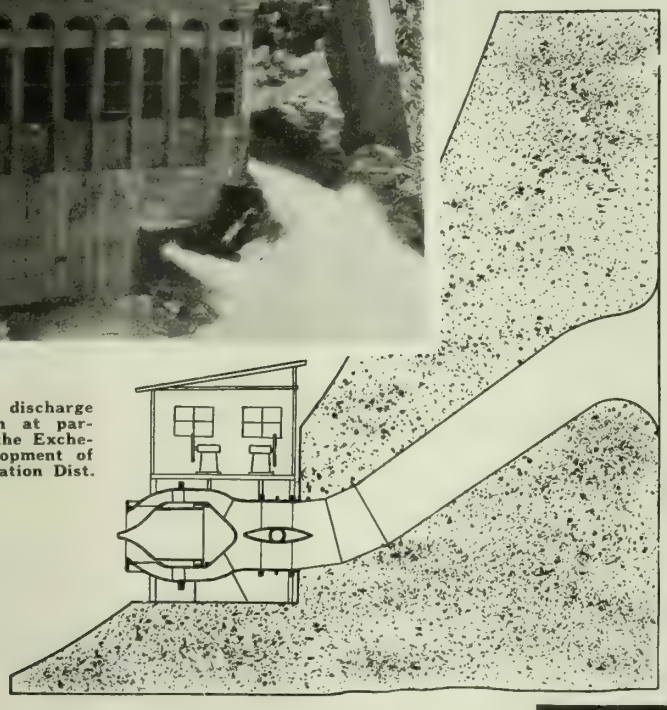


Two of the four discharge regulators shown at partial opening in the Exchequer Dam Development of the Merced Irrigation Dist.

Some Notable Installations

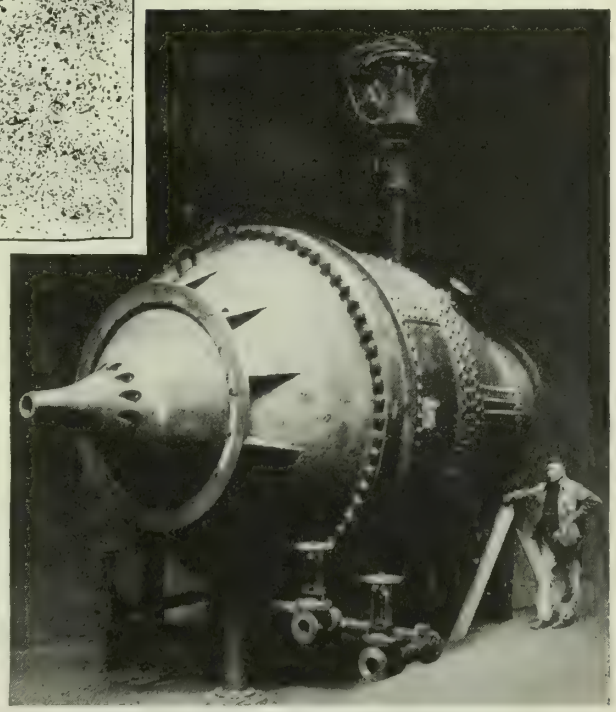
EXCHEQUER DAM, Merced Irrigation District—Two 72″ and two 60″ regulators, 290′ static head. One of the 72″ valves illustrated below.

MELONES DAM, Oakdale and South San Joaquin Irrigation Districts—Four 60″ regulators, 130′ static head.

CUSHMAN DAM, City of Tacoma—One 60″ regulator, 225′ static head.

CHEESEMAN DAM, City of Denver—One 60″ regulator, 60′ static head.

NORTH BOWMAN DAM, Nevada Irrigation District—One 48″ regulator, 205′ static head.



REGULATION of flow from irrigation storage reservoirs is an essential part of the irrigation system, since water must be released in varied quantities to meet seasonal requirements, whether or not hydraulic turbines are installed in the project. The water quantities required and the hydraulic conditions under which outlet valve operation must be maintained require the highest type of construction to insure positive control and continuous operation.

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Skagit River Project, Seattle

(*Continued from Page 33*)

can be developed as the current is needed and the financing can be undertaken. It eliminates long tunnels from the Ruby Dam and replaces them with storage reservoirs. It accomplishes the same end and avoids the interest charges on idle capacity.

The key to the Skagit River project is the Ruby Reservoir, capable of equalizing the flow of the river during the entire year, and providing the necessary water for the continuous generation of the 840,000 horsepower. Any plan of development that is undertaken must lead to its construction. The site is all solid granite and the proposed dam for the location will have a height of 520 feet, the length of crest being 2,000 feet. The elevation of the crest above mean sea level will be 1,690 feet and the depth to bedrock below low water 30 feet.

Timber a Problem

There are two obstacles which at the present time prevent the immediate construction of the Ruby Dam; namely, the time needed for the clearing of the timber in the valley which will be flooded, and the time and cost of material necessary to take the timber out of the valley and later bring the materials of construction to the dam.

The middle development plant calls for the erection of a second dam at the Diablo Canyon site. This is to be ultimately 365 feet in height, with a crest of 880 feet. The accompanying photograph shows how this dam will look when erected. Present plans estimate that the elevation of the crest of the finished structure will be 1,215 feet above mean sea level, and that the normal elevation of the water surface will be 1,200 feet above sea level. The concrete necessary for such a structure is estimated at 260,000 cubic yards. The foundation of this dam, like the Ruby Dam, will be on solid granite, but there will be necessary excavations of nearly 30 feet below the water line to provide for these foundations. The reservoir formed by this dam will extend for a distance of four miles up the river, and will have a capacity of nearly 90,000 acre feet.

The third dam will be located at the Gorge Creek site, and plans call for an arch type structure like the Ambursen or multiple arch dam. This structure will rest on a concrete mattress. The elevation at crest is estimated to be 895 feet above mean sea level, with a spillway at 880 feet. The reservoir created by this dam will extend approximately four miles back of the dam and have a storage capacity of 6000 acre feet.

For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Page 102

WESTERN Waterworks
Supplement to Modern Irrigation
Of Interest Expressly to Waterworks Executives, Contractors, and Municipal Engineers

California Gets 1928 Convention of A.W.W.A.; Chicago Meeting Is Record Breaker

By JAMES E. FOSTER

CALIFORNIA is slated as the meeting place of the American Water Works Association for its 48th annual convention in 1928, according to plans announced at the recent convention held in Chicago, June 6-11. Some point on the California coast, probably San Francisco, will be chosen as the convention city. The date has not yet been set.

The Chicago convention had a record-breaking attendance of 1600 and is reported one of the most generally successful meetings in the history of the Association. Officers elected for 1927-28 are as follows: President, James E. Gibson, manager and engineer, Water Department, Charleston, S. C.; vice-president, W. W. Brush, chief engineer, Department Water Supply, Gas and Electricity, New York City; treasurer, George C. Gensheimer, secretary Water Commission, Erie, Pa. The new trustees are: Seth M. Van Loan, Philadelphia; L. R. Howson, Chicago.

Nominations for 1928-29 were announced as follows: President, W. W. Brush; vice president, Jack J. Hinman, Iowa City, Iowa; trustees, C. D. Brown, Walkerville, Ont.; S. H. Taylor, New Bedford, Mass.; John Chambers, Louisville, Ky.

The exhibit of waterworks equipment was noticeably larger this year than ever before, with a total of 92 exhibitors. Practically everything a waterworks man uses in the way of equipment and material was shown. There were four exhibits of chlorinating equipment and chemicals, five of filtration equipment, twelve of pumps and well apparatus, seventeen of pipes and pipe auxiliaries, sixteen of meters and meter boxes, seventeen of valves, fittings and hydrants, three of steel tanks, five of construction and repair equipment, four of indicating instruments, and nine exhibits of miscellaneous equipment and publications.

Program of Papers

Industrial water supply, oil pollution, legal aspects of the waterworks industry, cement lined pipe and sewage treatment were among subjects of particular interest discussed at the convention.

High quality water is of prime importance to many industries, particularly those which use silk and wool as raw materials, according to W. D. Collins, chemist in charge, Quality of Water Division, U. S. Geological Survey. As a result these industries are confined to states which have an adequate supply of water. Since the cost of generating power and the life of physical equipment are largely dependent upon the quality of water used, factories generating power by steam must have a good supply of high quality water if efficiency is to be maintained.

The industrial importance of water has resulted in a tendency for many firms to make periodic analyses of the water they use, and keep records of its chemical characteristics.

Oil Pollution Covered

"The trouble from oil wells is due to the discharge of oil and salt water," said Almon J. Fales in a paper on oil pollution. "Crude oil may be separated from the water by a suitable skimming tank used in conjunction with the purification plant. If allowed to escape into the water supply, oil imparts a disagreeable taste and odor, and increases water purification expense. Salt in water increases its hardness.

"The principal effect of oil refineries on water supplies is due to the wash water from the agitators in which the crude gasoline and kerosene are purified. Aeration plus coagulation and filtration is beneficial. The ponding of wastes has been suggested as a means of fighting this evil."

Mr. Fales listed the following as the chief effects of oil pollution in general: destruction of shore property, destruction of aquatic life, increase of fire hazards and injury to public health.

Amarillo Water Supply

A description of the new water supply of Amarillo, Texas, was given by Wynkoop Kiersted. The water is secured from seven wells near Bibins Lake, a distance of about 15 miles southwest of the city. An impounding dam placed at one end of the lake forms a natural reservoir three and one-

half miles long and three-eighths of a mile wide. Adjacent to this dam is a 500,000 gallon receiving reservoir of reinforced concrete. This reservoir is 65 feet in diameter, with a concrete roof, supported on nine columns. The walls are 12 inches thick.

The water is carried from here by a 30-inch pipe line to a 5,000,000 gallon concrete reservoir in the city. It is then pumped into a 500,000 gallon tank which furnishes natural pressure.

Legal Aspects

Cecil F. Elmes, in a discussion of the legal aspects of the waterworks industry, drew attention to the following major issues recently decided by the United States Supreme Court in the Indianapolis Water case:

(a) The basis of valuation is reproduction cost at current prices.

(b) Going concern is a definite asset.

(c) Water Rights, where they exist, are also a real asset.

(d) Depreciation is a subject of practical measurement.

(e) Utilities are to earn a rate of return which will permit them to take care of their creditors and to compensate and protect their stockholders.

In speaking of depreciation, Mr. Elmes said that this problem could be successfully attacked only by adopting an inspection procedure, and that "straight line" tables and other similar methods of measuring depreciation in advance are unsound. In estimating value, the physical conditions under which a utility exists should also be considered. "As an example of what I am referring to, take pipe under a well paved street,'" he said. "This pipe is worth more, since it depreciates more slowly than pipe under an unpaved street."

The principal causes of failure in structural materials are, according to Mr. Elmes: wear and abrasion, corrosion, crystallization and other chemical or physical changes, sunlight, improper use, earthquakes, floods and other disasters, fire and neglect.

Cement Lined Pipe

In a paper on cement lining for cast iron pipe, H. Y. Carson, of the United States Cast Iron Pipe Company, stated that the American Water Works Association is making progress toward developing a specification for this type of lining, and will probably have it ready within a year.

"A study of old cement-lined pipe has shown that the effect of the water on the lining was negligible," he said. "The question is often asked: What effect has iron in water on this lining? Investigations of cement-lined pipe which has carried water with an iron content, prove that the iron does not penetrate the lining for more than one-sixty-fourth of an inch.

"In mining and oil regions there are wastes which can be handled best in pipe with this type of lining. This is due to the fact that the cement can successfully resist whatever chemical action this water may produce.

"The value of cement-lined cast iron pipe is greatest at high flows. In other words, as velocity increases, so does the value of the cement lining."

Sewage Treatment

The convention served a unique purpose in that it brought about a general discussion of sewage treatment and sanitation problems. During the first part of the week the Conference of State Sanitary Engineers held their annual meeting. At the close of the waterworks convention, a group of interested engineers and sanitary officials held a general gathering at which they discussed ways in which cooperation between sanitary officials might be increased.

The committee on Sewage Treatment of the Conference of State Sanitary Engineers recommended that the state health departments should have supervision over sewage and sewerage problems. "Most authorities will agree that certain fundamental laws having to do with sewerage and sewage treatment are necessary if proper collection and disposal of sewage is to be obtained," the committee's report said. "It is also probable that in most instances the health department is the best authority under whose jurisdiction such matters should be placed; at least the health department should take the lead and be a guiding factor in a centralized state authority."

The committee also suggested that the state health department have the authority to require the installation of proper sewage disposal facilities in order to fight stream pollution.

At the meeting held at the close of the waterworks convention, a discussion was brought up on the feasibility of organizing the sewage treatment plant managers into a national organization through state units. This gathering was attended by a group of engineers, university professors, manufacturers and representatives of interested organizations, including the Izaak Walton League.

Sprinklers Clean Reservoir

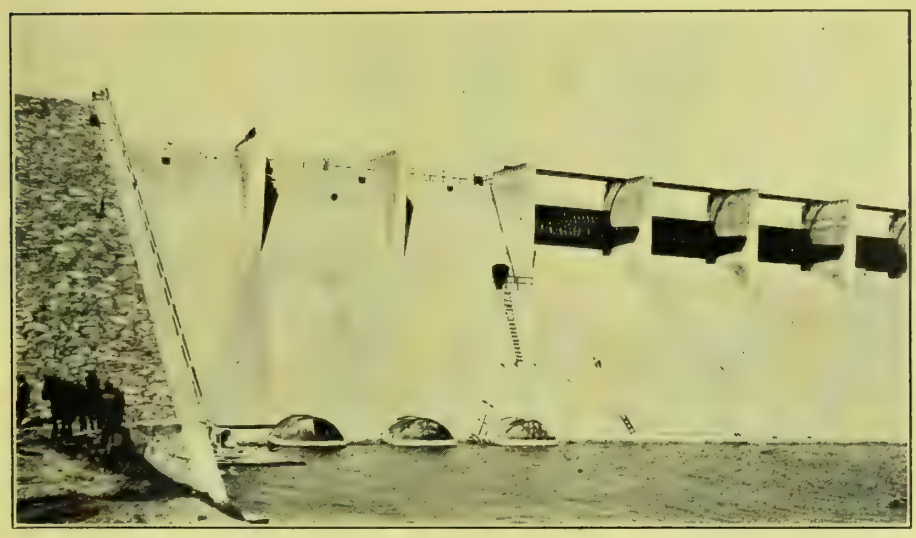
The reservoir sprinkler system of Auburn, Washington, has been installed and is reported to be working well. The sides of the big 3,000,000-gallon storage tank are now being much more quickly cleaned by means of the sprinkler. Formerly when the reservoir was cleaned it was necessary to shut down the hydraulic rams and let the reservoir drain out. Then when it was dry the water department brushed it down and washed the inside, the whole process taking from 24 to 36 hours. With the sprinkling system, the reservoir will be cleaned while it is being drained and will take only about 12 or 14 hours.

Newport Beach Gets New Well

Of primary importance to communities in the section about Newport Beach, California, is the recent announcement that a well has been sunk in the Santa Ana River basin which pierces a 200-foot water-bearing stratum. This is the third well now in use by the city, which owns several hundred acres of water-bearing land, and it is believed that the various water companies of that section will now have water in abundance. The well was sunk to a depth of 310 feet and is a 16-inch hole.

Lawrence M. Lawson, engineer of the Reclamation Service in charge of the Rio Grande Irrigation project, on June 9 was appointed as the American member of the United States-Mexican International Boundary Commission, succeeding former Governor George Curry of New Mexico, resigned. The commission was created by agreement of the two governments to settle permanently the line between the United States and Mexico as nearly as can be along the line it followed prior to the time the Rio Grande and Colorado rivers shifted their course. Modern Irrigation's readers will remember that Mr. Lawson is the author of the very interesting account of the Rio Grande Irrigation project published in the March, 1927, number.

State Engineer Herbert W. Yeo, of New Mexico, has recently returned from the San Juan Basin where rapid progress is being made on the topographic survey for a high line canal on the south side of the San Juan river. The tentative plan is to construct a combined storage and diversion dam at a point just below the confluence of Pump creek and run a high line canal down the south side of the river from that point to the east line of the Navajo reservation.



West end of the dam where the Government power plant eventually will be installed.

American Falls Project, Completed at a Cost of $8,500,000, Big Asset to Idaho

Dam, Turned Over April 20, 1927, Is 5,227 Feet Long, and Reservoir Above the Dam Is Second Largest Body of Water of Its Kind

THE completion of the American Falls storage reservoir, with a capacity of 1,700,000 acre feet is a mile-stone in the development of the Pacific Northwest. The estimated cost of this project was $8,500,000, or about $5 per acre foot. The financing was done in co-operation with many private enterprises operating in the Snake River Valley, and these private interests acquired in this manner about half of the storage capacity of the reservoir, the other half to be used for the proposed north unit of the Minidoka project and the Gooding project.

The government retained the potential power privilege, which amounts to about 40,000 horsepower, and the power so developed will be utilized by the various pumping installations in the north unit. The estimated cost of the power installation is $3,000,000 for the proposed four units of 10,000 horsepower each. However, there is not sufficient demand for the entire installation at the present time, so but one unit will be built immediately.

In turning over the dam on April 20, 1927, the general contract was brought to completion more than two months earlier than required. As completed, the dam is 5,227 feet in length; 83 feet high at its highest point, and 75 feet wide at its base.

Large Storage Basin

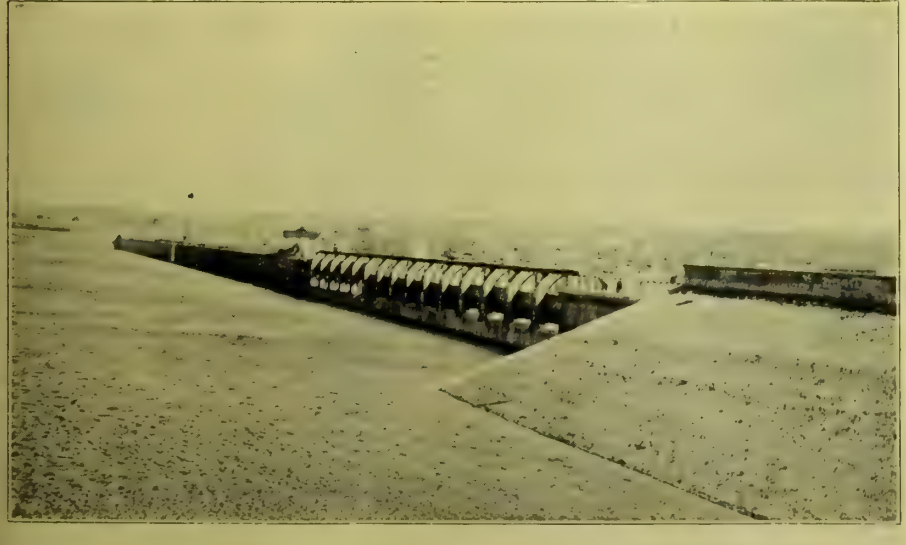
The reservoir above the dam is twenty-five miles in length, and has an average width of three and one-half miles. It has a shore line of 125 miles long, or the equivalent of the distance from Pocatello to Twin Falls. It is the second largest body of water of its kind in the United States; larger than the famous Roosevelt reservoir on the Salt River in Arizona, and being exceeded in size only by the Elephant Butte reservoir in New Mexico.

It has ten times the capacity of the Deer Flat reservoir and six times that of Arrowrock, or four times that of the two combined. It is Idaho's greatest body of water, being much larger than Lake Coeur d'Alene or Pend Oreille, the state's largest natural lakes; almost as large as both together. When filled to its maximum capacity it will inundate 61,000 acres of land, and cover an area of 88 square miles of territory.

In preparation for its first season of operation, the gates of the dam were closed on October 31, 1926, and all winter long the flow of the Snake River varied from 4,000 to 10,000 feet daily. Enough water has been released to fill Lake Walcott reservoir, having a capacity of 106,000 acre feet, and on April 9, 1927, American Falls passed the halfway mark, recording 850,000 acre feet. Early in May the water reached the level of the radial gates at the top of the dam, and the reservoir is expected to fill to capacity by June 30th. With an unusually heavy blanket of snow on the watershed, it is believed that some 500,000 to 750,000 acre feet of surplus water will flow over the spillways this year.

Of the 1,700,000 acre feet of storage that will be contained in the reservoir, supplemental water rights will be furnished to 1,000,000 acres of land, both above and below the dam. Approximately 500,000 acre feet will be retained by the government, and can be used for new

(*Continued on Page 64*)



Looking east across the great wall of concrete masonry toward American Falls, Idaho. The city which was moved to make way for the reservoir can be seen stretching along the east bank of Snake River.—Photos courtesy Chester Greene, Gooding, Idaho, and Victor Shawe.

The Use of Grit Chambers and Coarse Screens in the Small Municipal Sewage Plant

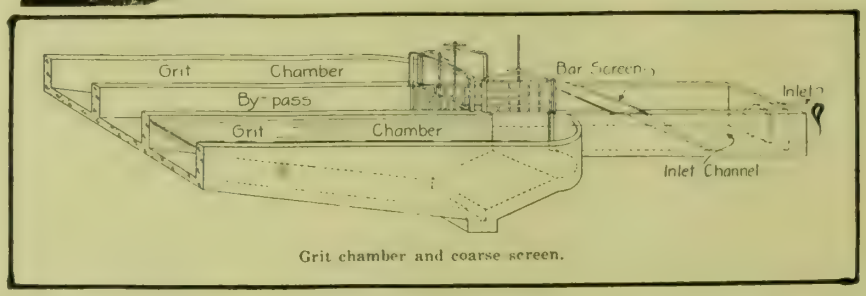
Like Many Other Operating Details, the Care of This Equipment is a Small Matter If Attended to But a Big Item If Overlooked

By HOWARD R. GREEN

*Howard R. Green Company**

IN THIS discussion of grit chambers and sewage screens an effort will be made to present useful information in non-technical form. Emphasis will be placed on equipment of types and designs usually found in installations of relatively small capacity, suitable for such communities.

The use of grit chambers and coarse screens usually forms the first step in sewage treatment, regardless of the size or type of the plant. Generally speaking, they are used in conjunction with the plant for protective purposes; that is, to free the sewage entering the plant from such material as would injure pumps or other machinery, or interfere with the proper progressive treatment of the sewage. In other words, the grit chamber is designed to remove sand, stones, and similar heavy materials, while the coarse screen removes the large lighter material, such as sticks and rags. Either of these classes of matter would injure pumps or fine screens, and heavy mineral matter in any quantity hampers the digestion and pumping of the sludge, while the lighter material helps to form a floating scum which is to be avoided.



Grit chamber and coarse screen.

Many of the older sewer system were a combination of sanitary drains and storm water sewers. They not only carried off the household wastes, but took care of the surface water from the streets as well. The first street washings of each storm carried great quantities of sand and pebbles. It was, of course, necessary to remove this heavy material before the sewage entered the treatment works proper. Also at times of heavy rainfall the sewers flowed full and the velocity was high. The only way to remove these heavy solids was to slow up the velocity sufficiently to allow the stones and sand to settle out. This was accomplished by running the sewage through a small tank or grit chamber which served to widen the area of flow, checking the speed or velocity, whereupon the objectionable material settled to the bottom and the sewage passed on through to the tanks. If this grit chamber was designed to serve its purpose during times of heavy rainfall when the rate of flow was high, trouble was encountered during dry seasons, when no storm water was running and only domestic sewage was carried by the sewers. A grit chamber big enough to slow up the heavy storm water run-off would during the dry season slow the smaller flow of domestic sewage to such an extent that organic matter would settle and become septic. The grit chamber then became a miniature septic tank, interfering with the delivery of fresh sewage to the main tanks.

Under today's conditions, nearly all our sewage systems have been separated so that the storm water is disposed of in one system of sewers, and the house drainage and industrial wastes in a separate system. The quantity of stones, sand and grit in the sanitary sewer system is, therefore, greatly reduced and the variation in flow during rains is not nearly as marked as it is in the combined system. A considerable quantity of grit still finds its way into the sanitary sewers through vent-holes in street manhole covers, from automobile washracks, etc. The grit chamber is still a necessity, though a troublesome one.

The average sewage disposal plant is designed to care for the entire population within the sanitary districts, and the several units of the plant are amply large to take care of the situation when all houses have been connected with the sewer system. Yet, during the first few years of a plant's operation, the quantity of sewage reaching it is only a small proportion of its capacity. During these first few years, the rate of flow is small. The velocity of the sewage passing through the grit chamber is, therefore, low, and as before stated, organic matter is deposited and the grit chamber becomes septic.

Quite often no means of cleaning the grit chamber except by shoveling is provided. The result is that it is seldom cleaned. The actual grit is mixed with foul-smelling organic matter and usually no means of disposal is provided. You have no doubt seen grit chambers so clogged with sludge and scum that only a narrow flow area was left for the sewage to pass through, thus defeating its purpose and rendering it the foulest place about the plant. Some grit chambers are provided with a valved outlet and a by-pass line to the outlet stream, whereby the operator can drain them frequently during times of high water when the filth will be carried away without apparent damage. Other plants have no river or stream outlet, hence no such easy way of disposal presents itself.

I think our tendency as engineers is to design grit chambers too large. I believe that if half the grit chamber area in most of the plants I have seen, including those of our own design, were walled off and the capacity cut in half, the grit would still deposit and a great deal of the organic matter would not. In some cases, this could easily be done by providing duplicate chambers, one to operate while the other is being cleaned. The discussion of the disposal of the grit chamber sediment will be left until the matter of screens has been discussed.

Two Classes of Screens

Sewage screens are of two general classes; coarse screens for the removal of sticks, rags and similar foreign materials; and fine screens for the removal of as much organic matter as possible. Coarse bar screens, or gratings in conjunction with grit chambers are good insurance for the satisfactory operation of the balance of any plant, small or

* Presented at the Eighth Conference on Sewage Treatment at Ames, Iowa, November 16, 17 and 18, 1926.

large. Fine screens, mechanically operated, are advisable only in large installations warranting the constant employment of caretakers. Screens having coarse openings larger than one-half inch are usually termed "coarse screens" although most coarse screens have one-inch openings or larger.

There are four general types of fine screens; the band screen, the wing screen, the drum screen and the inclined disc screen. The band, or revolving screen, consists of a broad belt of fine screen material running over two broad rollers, which are power-driven. The lower roller is of open construction and offers but little resistance to the passage of sewage through it. It is set well below the level of the sewage in a rectangular shaped flume or channel. The upper roller is set well above the level of the sewage and the revolving belt connects the two at an angle of about thirty degrees with the horizontal. The rollers revolve and the up-stream belt moves slowly upward as the sewage passes through, carrying the screened material on its surface. A revolving brush near the upper roller cleans the belt screen and deposits the screenings in a trough ready for disposal.

The wing, or shovel vane screen, operates like the stern paddlewheel of a river steam-boat, the paddles being replaced by fine screens and the wheels set across the sewage channel. The floor of the sewage channel is hollowed out, so that the edge of the screen makes a close contact with it, forcing all the sewage to pass through the screens. These paddle screens are cleaned by brushing after they have reached the point above the sewage level.

The Drum Type

The drum screen is a long revolving cylinder. The sewage flows into one end of this cylinder and as it rotates the screenings are carried upward and dumped on a conveyor which runs through the cylinder near the top from end to end. The screen is cleaned by jets of air or water.

The inclined disk-end cone type consists of a large circular disc of perforated brass set down in the sewage channel on such an incline that its upper half is above the water level. As the disc revolves, the sewage flows through the fine slots in the disc, and the screenings are carried up above the water level and brushed off by revolving brushes.

In the majority of installations, these fine screens find a variety of uses. Sometimes they precede the further tank treatment and in some cases they are located between the tanks and trickling filters for the purpose of reducing the amount of clogging in the nozzles.

In the last analysis the problem of the

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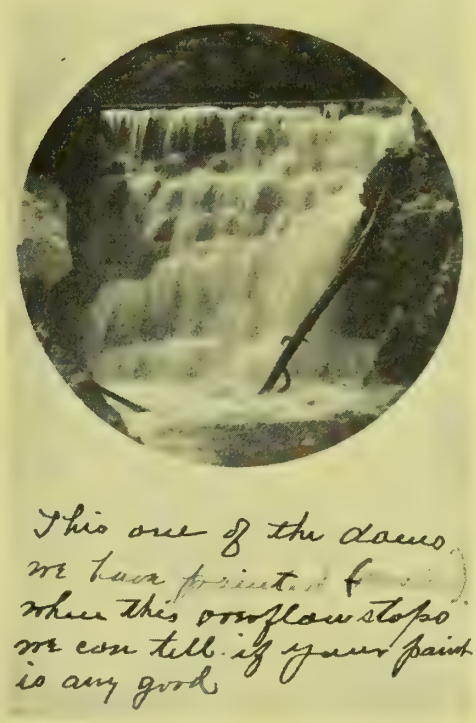

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sanitary engineer is to remove objectionable matter from sewage at the least possible cost. Each city or town has its separate problem. In many cases the fine screen has proven its worth, though they are not generally necessary or adaptable to the majority of small town plants thus far constructed in Iowa, and they are, therefore, simply mentioned in passing.

Types of Coarse Screens

There are two general types of coarse screens; the rack, and the grating. You are all familiar with the rack. It is simply a series of parallel bars or rods extending from well above the sewage level to the bottom of the rectangular channel through which the sewage is flowing. The grating is built and placed in the same manner, except that it has cross bars at frequent intervals, reducing the size of the screen openings. The rack type predominates.

As before stated, the coarse screen is usually set in connection with the grit chamber, and sometimes between the grit chamber and the tank, the latter location seems to be advisable. Sewage passing through the coarse screen often eddies, and these eddies tend to cause a deposit of the heavier organic matter. The chance of this deposit occurring in the grit chamber where it is not wanted is less if the screen follows the grit chamber than if it precedes it. Set at an angle of about thirty degrees with the vertical, the rack type of coarse screen is easily cleaned with an ordinary hand rake, so constructed that its teeth mesh with the bars of the rack. They should be cleaned at frequent intervals.

A clogged screen causes organic matter to deposit in the grit chamber. It frequently raises the water level in the grit chamber to such an extent that the sewage is backed up in the inlet sewer for a considerable distance causing deposit of sludge in the sewer itself, and the formation of scum. I have seen a serpent of scum six hundred feet long come winding out of an inlet sewer when a screen was first cleaned and the water level lowered.

Disposal Problem

And now comes the question of how to best dispose of the screenings and the accumulations in the bottom of the grit chamber. Operators have told me that they raked the screens regularly and put the screenings over into the main tank as being the easiest way of getting rid of them. In such a case, the screen is a nuisance to the operator and of no benefit to the plant. While the trash on a coarse screen or on the bottom of a grit chamber is not strictly sewage or sludge, it is so saturated with organic matter, partially decomposed, that it is offensive to the eyes and nose and cannot well be drawn out on the sludge drying bed. The best solution of the problem is to dig a pit near the grit chamber outside the plant and bury the trash, covering it well with earth.

For small plants a pit four feet square and five feet deep will take care of several months' accumulations without offense and without any great expenditure of labor. The cleaning and burying should be done at regular intervals of, say, once in two weeks in the plant caring for populations of from eight hundred to one thousand. There is much more chance of getting this work done in frequent installments which do not call for much labor, than there is of getting a nasty, distasteful job of considerable size done once a year. The only tools necessary are a garden rake with teeth properly set, a square end shovel bent to scrape the bottom from above, and a galvanized bushel basket. This work is just as essential to the complete and proper operation of the plant as any other single detail.

Like many other details of plant operation, the care of the grit chambers and sewage screens is a small matter if attended to, but a big item if overlooked.

Meters Tested for Gauging Rise of Rivers and Streams

The Mississippi flood having brought home to engineers the necessity for accurately gauging the flow of water in rivers and streams at different seasons of the year, the Bureau of Standards, on May 18, issued a statement concerning meter tests it has been conducting to aid in flood control.

Measuring instruments for the determination of the water's velocity have been tested in large numbers in the Bureau's specially built tank, according to the statement.

The full text follows:

The Bureau of Standards has for many years made a specialty of testing the current meters used for measuring the flow of water in rivers and other open channels. Last year 361 of these meters were tested in the Bureau's laboratory.

Determination of Volume

The determination of the volume of water flowing past a given point on the bank of a river in a given time is a matter of considerable difficulty. First, an accurate idea must be obtained by surveys and soundings of the cross-section of the river bed at that point. Next the velocity of the water at various locations up and down and along this cross-section must be measured. The

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product of the average velocity in feet per minute times the cross-sectional area of the stream in square feet gives the flow in cubic feet per minute of the stream. The velocities at various points are determined by a current meter which is either held by a man wading in the water or suspended from a boat anchored in the stream. As the water flows past the meter it turns a small propeller on the shaft of which inside the body of the instrument is mounted a commutator. A brush bears against this commutator, and two waterproof wires connect the instrument with a dry battery and a pair of telephone receivers carried by the observer. Every time the propellor turns he hears a click, and by counting the number of clicks per minute he can tell the speed of the water.

ACCURACY IMPORTANT

As in the case of any measuring instrument, if the results obtained by using the meter are to be of any value they must be accurate.

For calibrating water current meters the Bureau has built a tank 400 feet long, 6 feet deep and 6 feet wide. The water in this tank is stationary, and the meter is towed along by a small electric car which bridges over the tank and runs on rails placed along its sides. The car can be run at any desired speed and the speed can be recorded with extreme accuracy. If the meter is correct it will show the same speed as the car; if not, its plus or minus error can be determined.

This tank, which is one of the few such installations in the country, has proved of inestimable value to engineers and all those interested in water power development, flood control and irrigation.

Arizona Requests Permit to Develop Power on Colorado

Proposes Dam 1,200 Feet Long, Raising Water 90 Feet; Four Applications in Conflict.

The Board of Directors of State Institutions of Arizona has applied to the Federal Power Commission for a preliminary permit for a project on the Colorado River in Yuma and Mohave Counties, Arizona, and San Bernardino County, California.

The project would be near Parker, Ariz., and a small part of it would affect the Colorado River Indian Reservation. The application includes a proposed rock fill dam with a crest length of 1,200 feet and a bottom length of 600 feet, which would raise the water of the river 90 feet. A spillway would be situated 1,000 feet west of the dam on the California side of the river, it was stated.

The reservoir created by the dam would have a storage capacity of approximately 1,900,000 acre feet and would back up water to a point about two miles southeast of Needles, Calif. The power house would be located on the Arizona side at the dam, and power would also be developed at plants along an adjacent irrigation canal.

Primary capacity is listed as 100,000 horsepower, and probable installed capacity as 200,000 horsepower. The power would be used for irrigation purposes.

ACTION TO BE SUSPENDED

It was stated by the commission that all action on the application would be suspended in compliance with a Senate joint resolution of May 4, 1927, restricting the commission from "issuing or approving any permits or licenses affecting the Colorado River or any of its tributaries," until the Colorado River compact, signed at Santa Fe, N. M., November 24, 1922, has been approved by Congress, "or in the event that it is not sooner approved, until March 5, 1929."

The application conflicts with three other applicants for preliminary permits to make developments in the same vicinity, according to the commission. The other applicants are the Beckman & Linden Engineering Corp., San Francisco, Calif.; the City of Los Angeles, Calif., and the Southern California Edison Co., Los Angeles, Calif.

Melones Dam Illustrates Type

(*Continued from Page 27*)

mixers 60 S capacity, and was distributed by gravity to a hopper and then hauled in 2-yard cars pulled by Ford tractors on car wheels. The track gauge was 36-inch. The concrete mixers were all gear driven by 60 H.P. electric motors.

Engineers' estimates made before the contracts were awarded called for approximately 16,000 yards of excavation. These figures were based on diamond drill borings made at the dam site, but it was found that they did not cover the actual requirements. While the diamand drilling operations were conducted with the utmost care, their showings did not disclose the true condition of the subsurface strata, particularly the condition of the formations directly above the foundation bed. Excavation figures were more than doubled on account of this, but a good part of the increased amount was accounted for by the fact that the steep side walls had to be shot into the bottom, delaying excavation at the low points where the placement of concrete was to begin. Other delays were occasioned by the fact that the yardage necessary in the construction of the railroad ran into figures considerably beyond any

previous estimates, and it was not until December 8, 1925, that actual operations were begun. By this time the rainy season had set in, and the amount of water carried by the river exceeded the capacity of the flume.

Floods Big Handicap

When the flood waters had somewhat subsided, a thin section of the up-stream section of the dam was constructed to a height of about 30 feet and the entire width of the river bed. This was to act as a coffer dam. As soon as this was completed the river water was flumed over the other workings and excavation began on the downstream side, which constituted the major part of the footings. The high water, which again came at this particular time, made working conditions extremely difficult. The work of making a tight coffer-dam on the downstream side during this period was extremely expensive, the depth as well as the excavations that were necessary being considerably in excess of the original estimates; and the surface level was carried below the downstream surface level of the river.

The trestle method for the distribution of the concrete was used, and it was found that the cost was considerably less than by the usual chuting system. The lifts were made every 20 feet and it was found that this height worked out quite satisfactorily. The concrete aggregate was obtained from the Atlas Rock Company of Oakdale, and cement was supplied by the Santa Cruz Cement Company.

As previously stated, the quantities estimated in the contract were all exceeded, and in some cases more than doubled. The drum gates, the placing of which is sometimes a source of grief and trouble, were handled from the trestles, being spotted in place, and lowered into position by means of five-ton chain hoists. These gates were taken from the cars on the siding above the dam, loaded onto small carriages, and run over a small incline railway to the trestle on the crest of the dam. In this way, unnecessary handling was avoided.

Steel forms were used in the construction of the dam. These were found to be most satisfactory, and aided greatly in speeding up the work. The tunnel from the dam to the power house was cement lined, the cement gun being used for this purpose. Construction work was pushed as rapidly as possible and in keeping with good engineering and workmanship. On December 1st, 1926, there was considerable storage already behind the dam, and this water will continue to be stored until the full capacity of the reservoir is reached. The capacity of the storage basin is estimated to be 112,500 acre feet.

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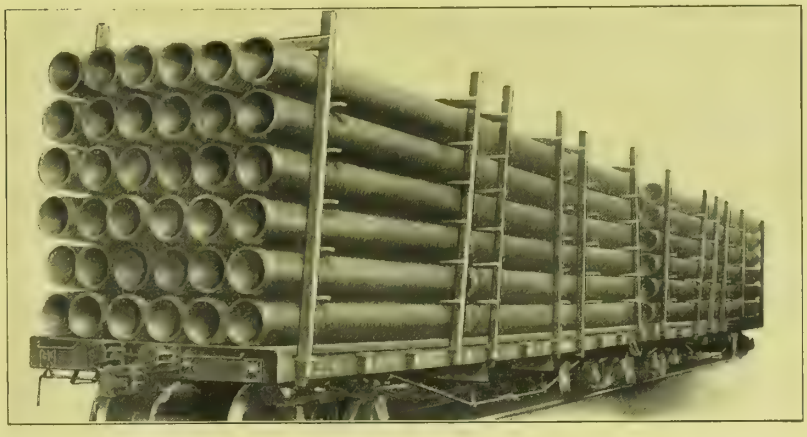

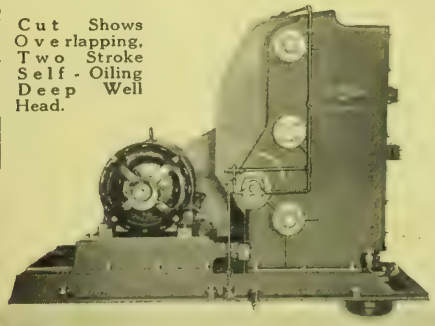

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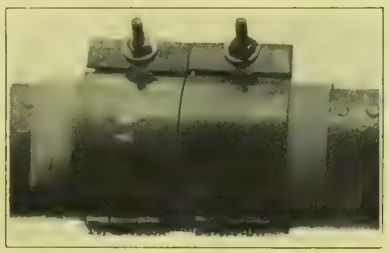

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SEWAGE DISPOSAL

New Reservoir Gives Aberdeen Water Reserve of 25,000,000 Gallons

THE new water reservoir on Fairview, into which Mayor Cloud turned the water a few days ago, gives to Aberdeen a total water reserve supply of about 25,000,000 gallons. Reservoir No. 1 holds about 10,000,000, the latest reservoir over 15,000,000.

The new reservoir was started July 15, 1925, when a contract was entered into by the city and Kennedy Brothers to excavate the highest point on Fairview for the basin of the new reservoir. This operation cost $56,978.30 and was completed September 22, 1926. The outlet and connection tunnel contract was let April 28, 1926 to the Wright Construction Company and completed August 18, 1926. This operation, included 592 cubic yards of tunnel excavation, 250 cubic yards of concrete and 26,745 pounds of steel re-enforcing.

The concrete lining and finishing contract was let August 11, 1926, to the Grays Harbor Construction company and by them sub-let to the Wright Construction Company. The work was completed January 26, 1927, at a cost of $56,768.85. This concrete lining was designed after a study of reservoirs built in many western cities, Seattle, Tacoma and Portland, and three built in Texas by the Reclamation Service. The lining of the reservoir was put in on two courses placed one as soon as possible after the other.

The first course was 5½ inches thick, concrete proportioned one part of cement to six parts fine and coarse aggregates. It was re-enforced by national wire mesh steel re-enforcing. The second course, one inch thick was of concrete waterproof topping containing 1 part cement to 1½ parts clean sharp sand.

Special Cement Used

The cement used in this construction was manufactured at Concrete Washington and was especially ground for this work, being reduced to such a fineness that 93 per cent of all cement used would pass through a sieve having 200 meshes per lineal inch. This extreme fineness made the surface waterproof.

The concrete lining was placed in slabs 21 feet square. Under all joints were supporting joint beams of concrete 6"x8". These joints were made waterproof, first by imbedding into adjacent slabs folded copper strips to take up expansion and contraction. The joints were then filled with special tar joint filler called "Petrolastic."

Springs were found in cutting down to the subgrade. Water from this source is carried away by a grid work of 6 and 4-inch drain tile which will pick up all water beneath the bed of the reservoir. The reservoir when full will hold 15,232,000 gallons and by a system of gate valves and by-passes, water coming from the Wishkah river through the gravity line can be brought directly to the city distribution system without entering either reservoir, or it can be put into either or both reservoirs, which are balanced to each other or working independent of each other or the supply as occasion requires.

Tests Satisfactory

Thorough tests were given reservoir No. 2 before the water was turned in and the results have been highly satisfactory. The fence around the reservoir, which is 8 feet high and a total length of 1136 feet, was recently completed. It not only adds to the appearance of the reservoir but protects the water from pollution, being placed several feet back from the parapet wall. The total cost of the reservoir was $126,009.80. The work was conducted under the direction of S. C. Watkins, superintendent and engineer of the water department, who was designing engineer. E. J. Austin, now city engineer of Hoquiam, was resident engineer and inspector on the concrete lining and tunnel work. Visitors from outside cities interested in waterwork construction have been united in commending reservoir No. 2 as one of the best reservoirs ever constructed in the Northwest.

The city council of Anacortes, Washington, has rejected all bids submitted for the two 500,000 gallon filter units which the city proposes to construct, and the clerk of the council has been instructed to call for new bids on revised specifications.

State Engineers' Conference Opposes Cross Connections

Practice Condemned as Cause of Outbreak of Typhoid and Other Diseases

Opposition to the use of connections, between potable public water supplies and supplies from other sources, because such have been the cause of outbreaks of typhoid fever and other water borne diseases, was expressed by the seventh annual Conference of State Sanitary Engineers held recently at Buffalo.

The full text of the statement by the Public Health Service follows:

Public Health Bulletin No. 169 has recently been released by the Public Health Service. It contains the transactions of the Seventh Conference of State Sanitary Engineers and is the seventh consecutive publication giving the proceedings of this organization of state health workers. The preceding bulletins are Numbers 120, 123, 133, 142, 154 and 160.

Resolutions Adopted

These transactions include principally the reports of committees, many of which have been working on their allotted subject for a number of years. In addition there are a few general discussions of public health engineering matters.

The report of the Committee on Cross Connections indicates that this conference is, generally speaking, opposed to them and the conclusions of the committee's investigation is summed up in the following resolution:

Whereas, cross connections, auxiliary intakes and by-passes between potable public water supplies and supplies from other sources have been the cause of a large number of outbreaks of typhoid fever or other water-borne disease, and

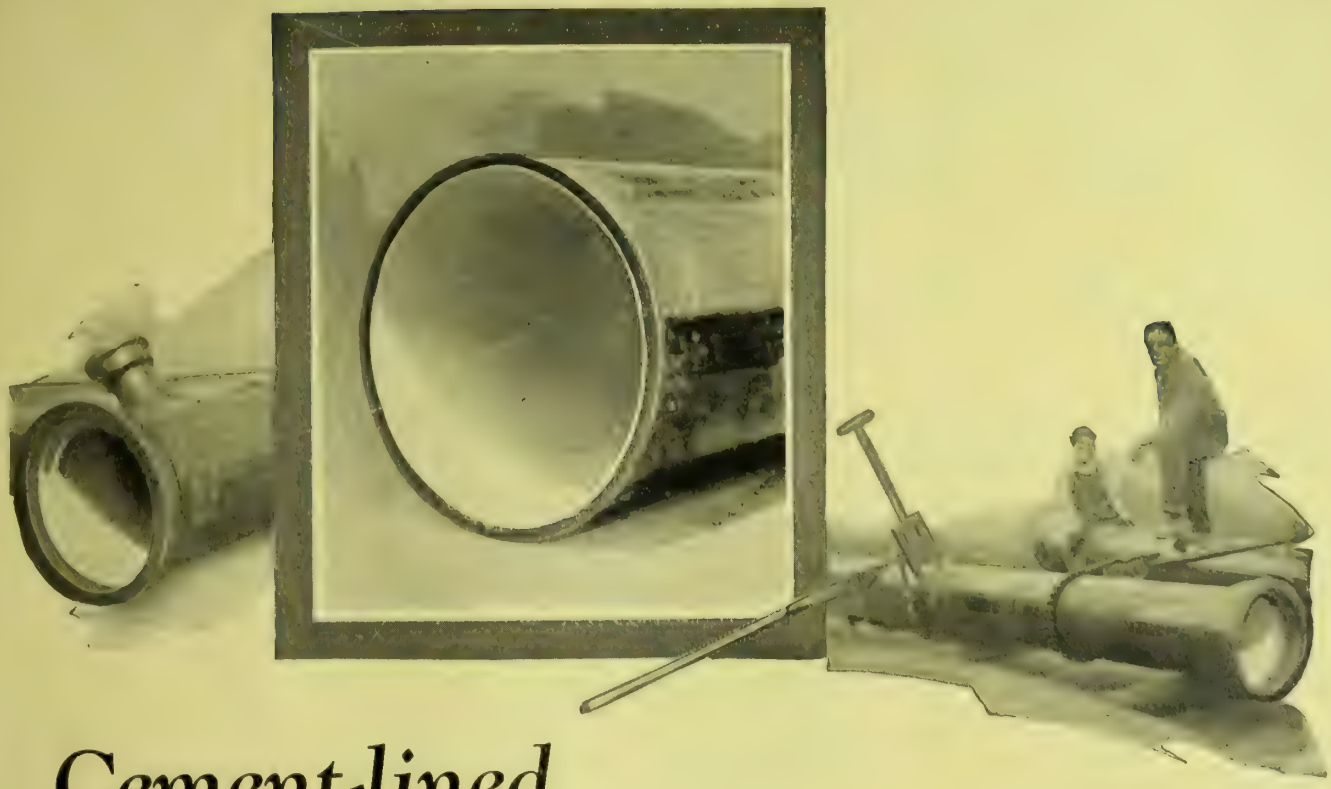
Whereas, check valves and other protective devices, or notifying the public in the case of using water from a polluted source through an auxiliary intake or by diverting the flow around an integral part of a purification plant through a by-pass, cannot be depended upon to adequately protect the public from disease,

Definite Program Urged

Be it resolved, that no physical connections should be permitted between any potable public water supplies either through cross connections, auxiliary intakes or by-passes and other supplies except as follows:

1. With another potable public water supply.

2. With a potable supply which is regularly examined as to its quality by those in charge of the potable public supply to which the connection is made.



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Further resolved, that definite programs should be inaugurated in each state and each municipality thereof to permanently eliminate all other connections, and be it

Further resolved, that the executive committee of this conference transmit copies of this resolution to the Fire Underwriters' Association and related organizations, also the American Water Works Association, New England Water Works Association and other analogous organizations.

Payette Basin Has Storage and Power Possibilities

The Interior Department, through the Geological Survey, has recently completed a survey of Payette River, Idaho, from Banks to Horseshoe Bend; North Fork to Cascade; South Fork to Grand Jean, and Deadwood River through Deadwood Basin; also of several large reservoir sites within the basin. In addition, field investigations of the power and storage possibilities were made. The flow of Payette River, like that of the other rivers of Idaho that discharge onto the Snake River Plains, is used largely for the irrigation of arid lands. At present somewhat more than 100,000 acres of land within the basin is irrigated, and nearly 75,000 acres more is estimated to be susceptible of irrigation. However, before there can be any decided increase in the irrigated area storage must be provided.

A report by W. G. Hoyt, hydraulic engineer, on the possibilities for storage and power, based upon these surveys and investigations indicates that there are at least 12 reservoir sites within the basin, which have a combined capacity of 1,200,000 acre-feet, and that only 150,000 to 200,000 acre-feet will be required for practically complete development of irrigation. Apparently the most feasible site for this storage is in Lower Deadwood Basin. Besides the storage sites the report describes 25 power sites at which it would be possible to develop somewhat over 100,000 horsepower during low-water seasons. By means of storage the potential power could be materially increased. The capacity of the individual sites ranges from 4,000 to 5,000 horsepower at low water, and it is expected that these may be developed gradually as the demands of the mining industry and of public utilities increase.

The report, which is in manuscript form, may be examined at the office of the Geological Survey in Washington, D. C., and at the district offices of the Geological Survey, Federal Building, Boise, Idaho, and Salt Lake City, Utah.

The maps, upon which the report is based, are on a scale of 2 inches to the mile, published in two colors in seven sheets entitled "Plan and profile of Payette River above Horseshoe Bend, North Fork to Cascade, South Fork to mile 70, and tributaries." They may be purchased from the Director of the Geological Survey for 70 cents.

Lake Pleasant Dam World's Highest Multiple Arch Dam

(Continued from Page 31)

delivered to them into the natural containing walls of the river. The economy of materials thus effected more than offsets the greater difficulties of construction and the very much greater amount of carpenter work required to build forms.

Spillway Details

The spillway of the Lake Pleasant Dam wastes into a second lake below the main storage dam, backed up against it by a diversion dam one and one-quarter miles farther downstream. When there is no wastage through the spillway, the impounded water behind the main dam is discharged through a six-foot valve into a 66-inch steel penstock 200 feet long and out again through a regulating needle-valve into the natural channel of the river. Two other outlets of the same diameter will be installed, for future power use.

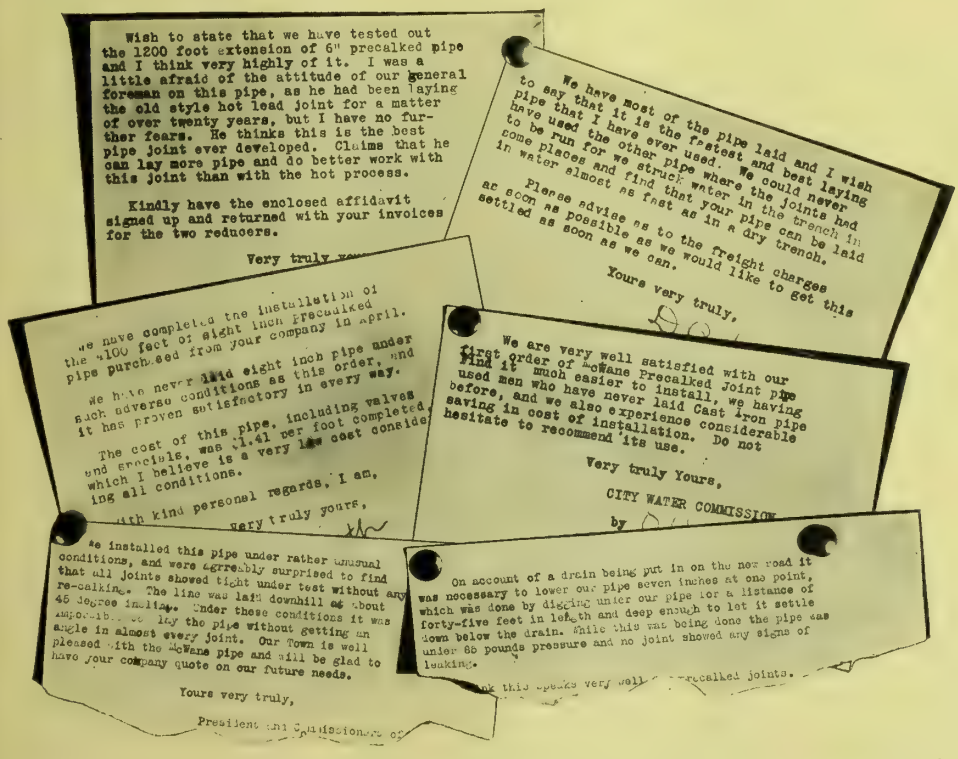
The diversion dam, of rubble masonry and gravity type, will back up the water behind it 10 feet against the main dam above. Its function is to recapture and save for irrigation use any water employed in the generation of power or passed through the main dam via the penstock and regulator valve. Out of this second lake opens the main irrigation canal, on the east side of the river, with a carrying capacity of 500 second feet.

Four miles downstream the canal crosses the river to the west shore in a metal flume supported by timber trestles, continuing for another eight miles to the northwest corner of the property to be irrigated. Within the property, it runs about 15 miles farther, gradually narrowing from a capacity of 500 to 20 second feet at the southerly end.

At each section line, laterals are taken off, running east and carrying from 100 second feet down to 10 and finally 7.5 second feet in the sublaterals. Each sublateral runs to the high point of the quarter section which it serves.

Frederick Hall Fowler, consulting civil engineer of San Francisco, addressed the Business and Professional Women's Club of that city recently on the Boulder Dam project.

You tell 'em, Customers! —we're too busy making pipe.



Wish to state that we have tested out the 1200 foot extension of 6" precalked pipe and I think very highly of it. I was a little afraid of the attitude of our general foreman on this pipe, as he had been laying the old style hot lead joint for a matter of over twenty years, but I have no further fears. He thinks this is the best pipe joint ever developed. Claims that he can lay more pipe and do better work with this joint than with the hot process.

Kindly have the enclosed affidavit signed up and returned with your invoices for the two reducers.

Very truly yours,

We have most of the pipe laid and I wish to say that it is the fastest and best laying pipe that I have ever used. We could never have used the other pipe where the joints had to be run for we struck water in the trench in some places and find that your pipe can be laid in water almost as fast as in a dry trench.

Please advise us as to the freight charges as soon as possible as we would like to get this settled as soon as we can.

Yours very truly,

We have completed the installation of the 4100 feet of eight inch precalked pipe purchased from your company in April.

We have never laid eight inch pipe under such adverse conditions as this order, and it has proven satisfactory in every way.

The cost of this pipe, including valves and specials, was $1.41 per foot completed which I believe is a very low cost considering all conditions.

With kind personal regards, I am,

Very truly yours,

We are very well satisfied with our first order of McWane Precalked Joint pipe and find it much easier to install, we having used men who have never laid Cast iron pipe before, and we also experience considerable saving in cost of installation. Do not hesitate to recommend its use.

Very truly Yours,

CITY WATER COMMISSION

by

We installed this pipe under rather unusual conditions, and were agreeably surprised to find that all joints showed tight under test without any re-calking. The line was laid downhill at about 45 degree incline. Under these conditions it was impossible to lay the pipe without getting an angle in almost every joint. Our Town is well pleased with the McWane pipe and will be glad to have your company quote on our future needs.

Yours very truly,

President and Commissioner of

On account of a drain being put in on the new road it was necessary to lower our pipe seven inches at one point, which was done by digging under our pipe for a distance of forty-five feet in length and deep enough to let it settle down below the drain. While this was being done the pipe was under 85 pounds pressure and no joint showed any signs of leaking.

We think this speaks very well for precalked joints.

BANG CAST
PRECALKED JOINT PIPE

Use McWane 1¼ and 2-inch CAST IRON pipe for services.

PACIFIC casting methods and the McWane Joint combined afford a flexibility and self-tightening feature that insure against trouble ordinarily feared with cast iron pipe.

Ask for full details and prices. Lowest cost PER YEAR of any pipe.

Western-Made Cast Iron Pipe

Furnished either with or without the famous McWane Precalked Joints. B. and S. type. Precalked Fittings. Foundry shipments made promptly from Provo plants.

Pipe Sizes: 1¼, 2, 3, 4, 6 and 8 inches. Standard lengths.

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General Offices and Foundries: PROVO, UTAH

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LOS ANGELES

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PORTLAND, OREGON

McWANE CAST IRON PIPE CO.

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For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Page 102

WATER PURIFICATION

Orthotolidine As a Qualitative Test for Detection of Free Chlorine in Water

By EMERY J. THERIAULT
Chemist, United States Public Health Service

ORTHOTOLIDINE was first proposed by Phelps (1909) as a qualitative test for the detection of minute amounts of free chlorine and hypochlorites "in connection with a court case in which the presence or absence of residual available chlorine was a matter in dispute" (*cf.* Phelps and Shoub, 1917, p. 769).

According to Kinnicutt (1909) the reagent employed by Phelps consisted of a solution of orthotolidine in dilute sulphuric acid.

Seith (1913), without success, used a solution containing 0.1 per cent of orthotolidine in 10 per cent acetic acid. "Instead of a yellow color in the more dilute samples which had been treated with hypochlorite, a green color appeared which gradually deepened and changed to yellow and finally to deep red as the concentration of free chlorine increased." In one instance a light blue color was obtained. "No explanation for this is attempted."

Tests by Ellms and Hauser

Ellms and Hauser (1913), using the acetic acid solution of Seith (1913), concluded that "the variations in the colors formed appeared to be intimately associated with the original degree of (titratable) alkalinity of the water * * *. The higher the original alkalinity of the water containing free chlorine, the bluer is the shade of color produced. The more nearly neutral is the water being examined, the yellower the tint." On the other hand, Ellms and Hauser also found that, even with small amounts of free chlorine, a deep yellow color is produced when the orthotolidine reagent is prepared with hydrochloric acid. They accordingly proposed the use of a reagent containing "one-tenth per cent *o*–tolidine in a 10 per cent solution of hydrochloric acid. This reagent does not deteriorate on standing." The more recent studies of Clark, Cohen, and Gibbs (1926, p. 41) have furnished a very satisfactory explanation for the color transformations of orthotolidine. "A return to the blue color test would be useful in the examination of colored waters and could now be logically designed, but it is improbable that the specifications would be simple enough for field use."

Ellms and Hauser (1914) experimented with a sulphuric acid solution of orthotolidine. "It is apparent from these tests that a sulphuric acid solution of orthotolidine is not as much affected by ferric salts and nitrites as is the hydrochloric acid solution. However, a sulphuric acid solution of orthotolidine is not as easily prepared as one of hydrochloric acid and * * * does not seem to be able to indicate quite as small amounts of free chlorine as does the hydrochloric acid solution."

Forsberg (1926) concludes that "dilute solutions of ferrous and manganous salts, up to 10 p. p. m., do not react with orthotolidine." Also, "for all practical purposes, ferric salts do not interfere with the accuracy of the orthotolidine test." However, "water containing manganese as manganic hydroxides gives the same reaction with orthotolidine as chlorinated water, irrespective of whether a water, alcohol, sulphuric or hydrochloric acid solution of the reagent is used." Interference by manganese compounds has also been reported by Olzewiski (1923), Hale (1926), Montfort (1926), and others. Montfort (1926) also considers that when applied to the determination of free chlorine in water treated with hypochlorites, "the orthotolidine test becomes one for chlorates rather than for chlorine."

According to "Standard Methods for the Examination of Water and Sewage" (1917, 3d edition), the reagent in question was to be prepared by dissolving one gram of orthotolidine, purified by recrystallization from alcohol, in 1 liter of 10 per cent hydrochloric acid. By weight, therefore, there should be added

$$\text{about} \frac{100}{(1.18)\ (0.3539)} = 240 \text{ c. c. of } 35$$

per cent HCl per liter. These directions were repeated in "Standard Methods" for 1920. In more recent editions it is specified that the reagent should be prepared by dissolving 1 gram of orthotolidine, melting point 129° C., in 1 liter of dilute hydrochloric acid ("100 c. c. concentrated acid to 1 liter.") Orthotolidine of the requisite purity may be obtained from a designated manufacturer or else it may be prepared "by extraction from water from the technical product in a Soxhlet apparatus" (5th edition, 1923, first reprinting, p. 44; see also 6th edition, 1925, p. 44).

Roake (1925) found it difficult to prepare the orthotolidine reagent by the usual procedure of dissolving one gram of the recrystallized salt in one liter of 10 per cent hydrochloric acid. The orthotolidine does not dissolve completely, at least in a reasonable time, and, on filtering off the undissolved part, a weaker solution is obtained than called for. In certain cases this might lead to appreciable error. Roake gives the following directions for preparing the reagent:

"To 1 gram of *o*–tolidine add the calculated amount of hydrochloric acid ("about 236 c. c."), stir well, dilute to about 500 c. c. and filter. The residue left on the filter will be found to be soluble in distilled water. Make up to 1 liter."

The following procedure avoids the filtration recommended by Roake and gives very satisfactory results.

Preparation of Reagent

1. Weigh out 1 gram of orthotolidine, transfer to a 6-inch mortar, and add 5 c. c. of 1:5 hydrochloric acid (previously prepared by adding 100 c. c. of concentrated hydrochloric acid, sp. gr. 1.18–1.19, to 400 c. c. of distilled water).

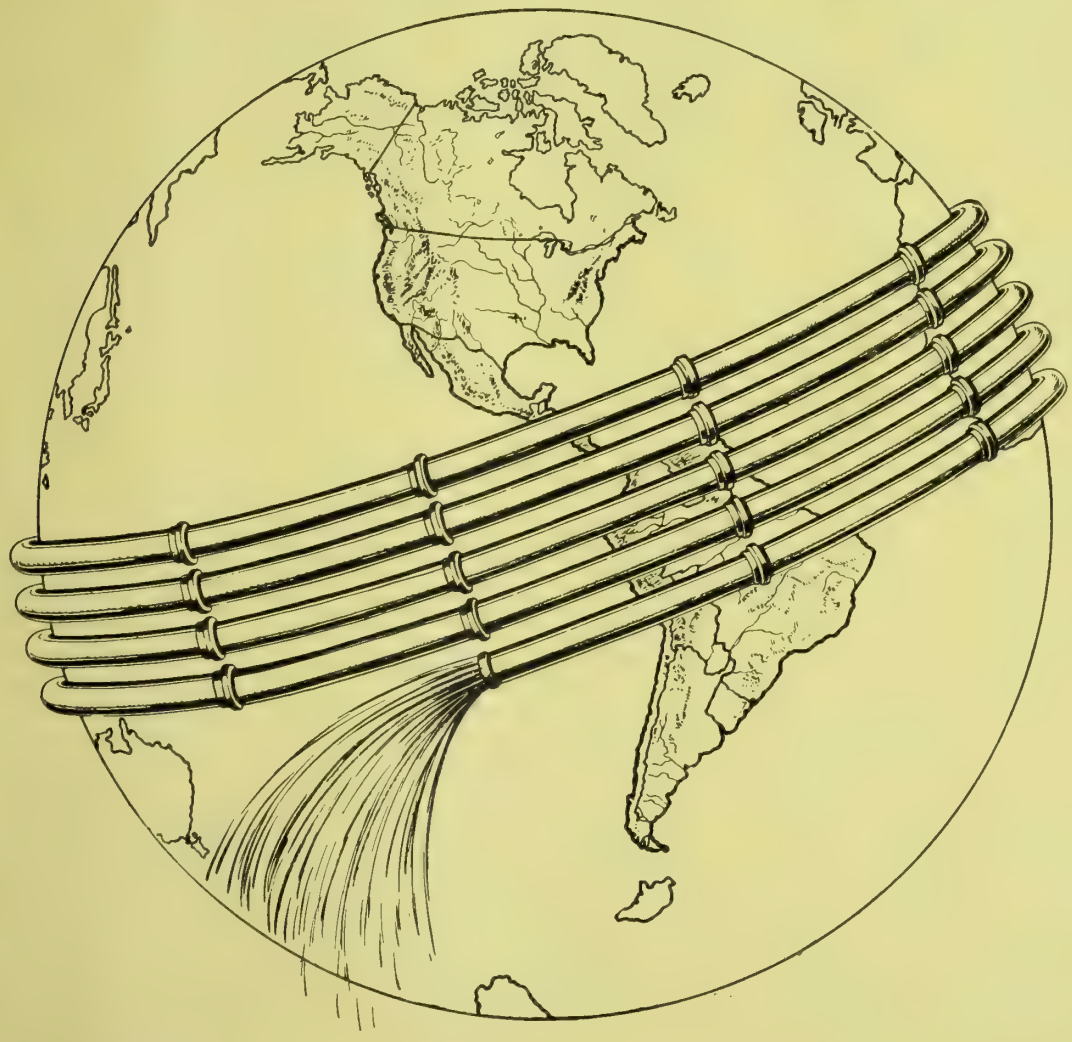
2. Grind to a thin paste and add 150 to 200 c. c. of distilled water. The orthotolidine goes into solution immediately.

3. Transfer to a 1,000 c. c. graduate and make up to 505 c. c. with distilled water.

4. Make up to the 1,000 c. c. mark by adding the balance (495 c. c.) of the 1:5 hydrochloric acid.

These directions are based on the fact that, while orthotolidine itself is quite insoluble in distilled water, the compound obtained by treating it with a small amount of hydrochloric acid is relatively soluble. (One gram of orthotolidine treated with 5 c. c. of 1:5 HCl will dissolve in about 60 c. c. of distilled water.) As the hydrochloride which is presumably formed is relatively insoluble in hydrochloric acid, the solution is first diluted to 505 c. c. before adding the balance of the hydrochloric acid. The reagent prepared in this manner will

Five Times Around the World!



More than six thousand installations of W & T CHLORINE CONTROL APPARATUS sterilize each day enough water to fill *a 12 inch pipe five times around the world!*

This indicates the paramount value of Chlorination in the protection of Public Water Supplies.

"The only safe Water is a Sterilized Water"

TECHNICAL PUBLICATION NUMBER 42 "CHLORINE IN SEWAGE PURIFICATION" WILL BE MAILED ON REQUEST

WALLACE & TIERNAN
COMPANY, INCORPORATED
Manufacturers of Chlorine Control Apparatus
NEWARK NEW JERSEY

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contain 1 gram of orthotolidine and 100 c. c. concentrated hydrochloric acid, specific gravity 1.18–1.19, per liter, in exact conformity with Standard Methods. The directions may also be used for the preparation of a reagent containing 10 per cent of HCl *by weight* corresponding roughly to 240 c. c. of concentrated hydrochloric acid, specific gravity 1.18–1.19, per liter. Also, using only 100 c. c. of concentrated acid, a reagent may easily be prepared which contains 2 grams of orthotolidine per liter.

The desired yellowish colorations will be obtained when 1 c. c. of the usual reagent is added to 100 c. c. of a chlorine-containing sample, provided *(a)* that its volumetric alkalinity does not exceed, say, 400 or 500 parts per million, and *(b)* that its chlorine content is less than 4 or 5 parts per million *(cf.* Ellms and Hauser, 1912; also Muer and Hale, 1925). When the volumetric alkalinity of the sample is too high, it is a matter of common knowledge that bluish-green colorations are obtained. On the other hand, in solutions which are distinctly acid, orange-red colorations may result if relatively large amounts of free chlorine are present. These reddish hues tend to become lighter in color as the amount of chlorine is increased, and, if a sufficient excess of free chlorine is added, yellowish colorations may eventually be again obtained. At higher pH values, almost any desired shade of color may be obtained by varying the proportion of reagent added to the amount of free chlorine present. In this connection it is interesting to note that a field test for hypochlorite dosage which depends on the formation of an orange-red color with orthotolidine has recently been adopted by the Medical Department of the United States Army (Anon., 1925).

Advantages of Stronger Solution

Muer and Hale (1925) recommend that 5 c. c. of reagent (1 gram of orthotolidine in 1,000 c. c. of water containing 100 c. c. of concentrated HCl) be used when the sample under examination contains from 1 to 10 parts per million of free chlorine. Five cubic centimeters of orthotolidine reagent added to 100 c. c. of a chlorinated sample should also give a suitable acid solution even with exceedingly hard waters. If desired, a reagent of somewhat greater strength in respect both to orthotolidine and to acid content could be prepared by the procedure described above. For general use, such a reagent might possess certain advantages over the more dilute solution.

Finally, it may be remarked that, using the method of Palkin (1923), notable differences were found to exist in the actual orthotolidine content of four widely advertised brands of this chemical. The color of the reagents prepared from these four samples of orthotolidine also differed appreciably. On the score of cleanliness, actual purity, and clarity of the resulting reagent, the brand recommended in Standard Methods (1925, p. 44) is undoubtedly to be preferred. However, as a practical matter, it is to be noted that the sensitiveness to free chlorine of the reagents prepared with these four different brands of orthotolidine was very much the same regardless of the color of the reagent or the purity of the chemical. Furthermore, excluding gross impurities, all four brands were found to dissolve completely and with equal facility in a solution containing 10 per cent of HCl by weight.

Lime Treatment of Water Not Comparable to Chlorination

U. S. Public Health Service Gives Results of Experiments at Cincinnati Laboratory

Experiments made by the United States Public Health Service have failed to show that excess lime treatment of water gives a bacterial purification comparable to that of chlorination of the water, the Public Health Service announced in a statement on May 7.

A report submitted by the experimental laboratory at Cincinnati was made the basis of the statement issued by the service.

The full text of the statement follows:

The United States Public Health Service has for many years maintained an experimental laboratory at Cincinnati, Ohio, where studies of water purification and methods of sewage disposal have been conducted.

In a progress report submitted by this laboratory to the Public Health Service during March, the operation of the experimental water purification plant was recorded as having been in use during 21 days of the month, for a total of 414 hours. The total volume of water treated being 1,357,980 gallons, of which 1,088,630 gallons consisted of river water, and 269,350 gallons of sewage and dilution water.

Tests on River Water

During the period in which river water was pumped a series of observations was made, using treatment of the raw water with an excess of lime in order to study the possibility of substituting this form of treatment for chlorination in instances where taste-producing phenols are present in raw water. This method is being tried experimentally at the Cincinnati municipal filtration plant, and at a number of water-softening plants, but little definite information exists as to its possibilities for the bacterial purification of water such as that of the Ohio River.

The results of these operations have not thus far shown that the excess lime treatment gives a bacterial purification comparable to that of chlorination of the filter effluent. These observations will be conducted in order to determine this point more definitely.

Combining field work with laboratory investigation has resulted in great progress being made in solving detailed problems in connection with methods of purification of river water for drinking purposes, and also in methods of simplifying the various processes adapted for the more scientific disposal of sewage and other industrial wastes being discharged by manufacturing plants into the navigable streams of this country.

This work of the Public Health Service is carried on in co-operation with various state boards of health and municipal water purification and sewage treatment plants.

American Falls Water Project Is Big Asset to Idaho

(Continued from Page 51)

projects among them the Shoshone project, the Minidoka extension, the Empire district, and the Greater Fort Hall project, the latter tributary to American Falls and part of it under irrigation.

Up to the present time subscribers to the project have contributed $3,335,-744.49 toward its cost. The twenty-three irrigation districts, companies and individuals co-operating with the government include the Aberdeen-Springfield Canal Company, American Falls Reservoir District, Blackfoot Irrigation Company, Burgess Canal & Irrigation Company, Butte & Market Lake Canal Company, Corbett Slough Ditch Company, Dilts Irrigation Company, Enterprise Canal Company, Ltd., Harrison Canal & Irrigating Company, Hillsdale Irrigation District, Lenroot Canal Company, Milner Low Lift Irrigation District, Mrs. Katriene Meier-Nandorf, New Sweden Irrigation District, People's Canal & Irrigation Company, Poplar Irrigation District, Progressive Irrigation District, Reid Canal Company, Charles D. Smith, Snake River Valley Irrigation District, Trego Ditch Company and Utah-Idaho Sugar Company.

Officers and directors of the American Falls Reservoir District are R. E. Shepherd, Jerome, president; E. B. Johnson, Twin Falls, secretary; A. F. McCloud, Wendell; H. K. Thayer, Bliss; J. H. Barker, Buhl, and W. H. Spence, Kimberly. Administration of the affairs of the reservoir is vested in an advisory board, of which R. E. Shepherd is chairman, and A. A. Davis, of Filer, secretary.

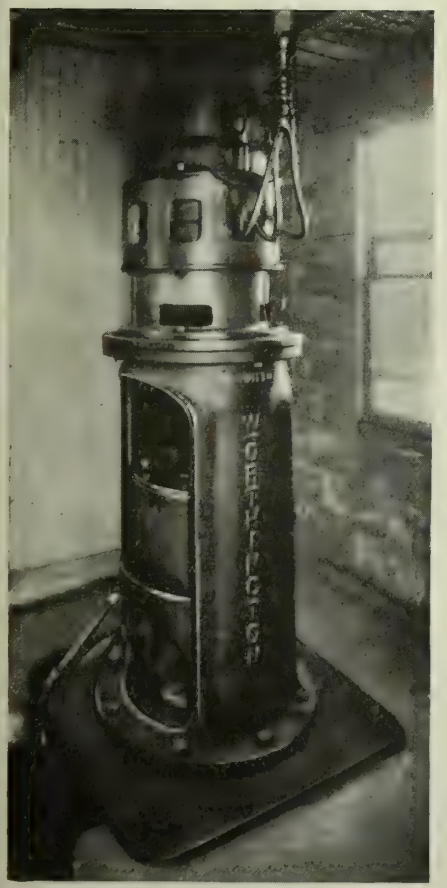
CATALOG SECTION

A Survey of the Leading Supplies and Equipment Used in the Construction of Hydraulic Dams, Power Plants and Auxiliary Works

Sand Holds No Terror for the Coniflo Deep-Well Pump

New York Water Company Makes Tests That Show Fine Performance on the Part of This Worthington Product

Several years ago the Endicott (N. Y.) Waterworks Company became interested in replacing their air-lift pumping system with Worthington Coniflo (reg. U. S. Pat. office) deep-well pumps. At first this waterworks company was skeptical about the successful operation of deep-well pumps, fearing that difficulties might be encountered due to sand. After carefully considering all factors, it was decided to try to eliminate the sand.



Interior of one of the four pump houses at Endicott Waterworks, showing one of the four Coniflo deep-well pumps.

A two-inch air line, equipped with a quick opening valve, was lowered to the bottom of the well and so arranged with ropes and pulleys that the line could be raised or lowered as desired. Air at from 80 to 90 lb. per sq. in. pressure was fed to the line. By quickly opening the air valve and moving the air line up and down to agitate and upset the formation in the bottom, the sand and gravel were gradually pumped out by air lift until a large cavity was formed. This cavity was evidently lined with large stone and gravel too heavy to raise. Thus a very effective screen was formed which kept the sand back, and there has been no trace of sand since the Coniflo pump was installed.

The pumps raise water from a depth of approximately 75 feet to an elevation of 10 feet above ground. The average power consumption for the year 1926 was 0.6 kw. per 1000 gallons.

Establish Factory Branch

Word has recently been received that the American Pump Company, with sales offices at 420 East Third Street, Los Angeles, California, has taken over these offices and is now operating them as a direct factory branch. Edgar Bush is the sales engineer representing the company.

This permits the company to give better service to its customers in southern California, the company explains, and to build the foundation for an even larger representation on the Pacific Coast.

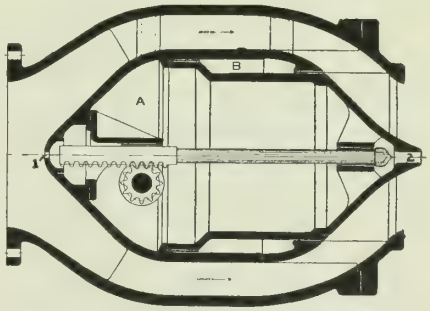
The American Pump Company recently has perfected a non-clogging sewage pump so designed that it is virtually impossible to make it clog. This pump has caused a great deal of comment among engineers and sewage experts. The impeller is a one port non-clogging affair, which, for example, will allow a 4-inch pump to pass a 3-inch sphere, a pumping feat that seems almost impossible.

The Falk Corporation of Milwaukee, Wisconsin, manufacturers of Herringbone gears, speed reducers, steel castings, diesel engines and flexible couplings, have opened an office in Chicago at 122 South Michigan Avenue. The office will be in charge of C. H. Thomas.

The Application of the Johnson Valve to Irrigation Dams

Pelton Water Wheel Co. Has Made Notable Installations On Storage Dam Outlets

Practically all of the large irrigation projects of the United States are located in the western states, where large storage reservoirs are created through the erection of dams which impound waters of the spring run-off, making it available for seasonal use as irrigation interests require it. In many cases, a considerable head is created permitting the economical installation of hydro-electric equipment and earning an additional income through the sale of power as the stored water is released. Obviously, the hydraulic turbines installed in such instances must be capable of efficient operation under a variable head and at some seasons of the year operation is suspended due to lack of water or the fact that water is not required for irrigation.



Cross Section of the Johnson Valve.

Valve Described

Whether or not hydraulic turbines are installed there must be a positive means of passing irrigation water through the dam at prescribed rates of flow and under such conditions that the water conduit, valve mechanism included, will withstand continuous operation under a varying pressure and at all positions of partial opening. An outlet valve, whose moving element travels parallel to the flow of the water has proven to be the best means of controlling the discharge of large quantities of water efficiently and economically.

The Johnson balanced plunger valve was invented in the late 80's by Raymond D. Johnson of New York while employed as a consulting engineer by a large public utility. It was first conceived as a penstock valve for controlling the entrance of water into hydraulic turbines, its operating principles, however, being readily adapted for use in irrigation dams as the need became apparent. The Johnson valve consists essentially of a steel casing within which is placed a plunger with a stationary element at the upstream end. The plunger moves within this stationary element parallel to the direction of flow of the water. The pressure which is in the pipe above the valve is utilized for movement of the plunger in either direction, pressure being applied and released at different ends of the plunger by hand and motor-operated controls. The following description, with references to the accompanying sketch, gives a comprehensive idea of the manner in which the valve operates:

How Valve Operates

The valve is in full open position, being held firmly in that position by pressure exerted against the upstream end of the plunger in chamber B, a series of small ports allowing pressure to enter chamber B at all times. The discharge reaction also tends to hold the valve in open position. In the open position there is practically no pressure behind the plunger since the area of port (2) is considerably larger than the area of port (1) the latter being always open. To move the plunger to closed position, the central pilot valve operated by rack and pinion, is moved forward, closing port (2) and water, being allowed to enter port (1) builds up a pressure in chamber A. Since the area of the plunger subjected to pressure from chamber A is considerably in excess of the annular area of the plunger under pressure from chamber B, the plunger moves forward to the closed position at a rate determined by the speed of movement of the control actuating the pilot valve. The opening movement of the plunger begins as the pilot valve is withdrawn, exhausting the pressure in chamber A and allowing the pressure in chamber B to open the plunger.

Many notable installations of Johnson valves have been made throughout the west, the largest yet utilized for storage dam outlets having been designed and built in the San Francisco works of the Pelton Water Wheel Co., who are licensees for the Johnson valve. Some of the outstanding installations of these valves are mentioned in the Pelton Water Wheel Co. advertisement appearing elsewhere in this issue.

Link-Belt's Crawler Shovel Is "Built for Service"

Simplicity of Design and Sturdy Construction Are Outstanding Features of This Piece of Equipment

The Link-Belt "Built for Service" Crawler Shovel is equipped with a very heavy built-up boom, made of seasoned white oak armored with heavy steel plate on top, bottom and sides, and bolted together with large forged steel bolts, to endure properly the severe loads, twists and strains incident to most shovel work under which other forms of booms usually have very short life and require excessive maintenance. The dipper stick likewise is built of large timber center, with heavy steel armor plates on all sides, and with heavy crowding rack of extra length, engaging with the pinion of the crowding mechanism.

All of this company's dippers are rated on the basis of actual struck measure, and the crown load capacity is approximately 25 per cent greater. The standard dipper is of all manganese steel construction, with straight front or flared front to suit the work to be done, and with renewable manganese teeth. Where conditions make it advisable, dippers of lighter construction can be furnished.

Rope crowd is recommended for most work; but for a certain few conditions where the shovel is required to work in very restricted and cramped quarters, independent crowd can be furnished, at extra cost.

Only 19 Gears

The clutches have only one point of adjustment, and are, like the brakes and drums, of large dimensions.

There are only 19 gears in the whole machine; four of which are in the lower frame. These are protected by being totally enclosed in oil tight cast steel housings.

Both upper and lower frames are of one-piece cast steel.

The standard dipper shovel consists of heavy-duty steel-armored white oak boom and dipper stick with crowding rack, and with heavy-duty all-manganese steel bucket of 1 cu. yd. struck measure capacity for the K-35 machine, and of 1¼ cu. yd. struck measure capacity for the K-42 machine.

Because of the severe nature of practically all dipper shovel work, the company furnishes as standard equipment and recommends the above heavy-duty type of equipment for dipper shovel service as generally encountered.

Full information may be had, by requesting Catalog No. 895 at any Link-Belt office; see ad, page 7.

APPROXIMATE OPERATING SPEEDS, DIPPER LINE PULL, ETC., FOR DIPPER SHOVEL SERVICE

	K-35 machine with 75 H.P. internal combustion engine or 50 H.P. electric motor	K-42 machine with 87 H.P. internal combustion engine or 60 H.P. electric motor
Dipper hoist line speed per minute	160 feet	155 feet
Maximum dipper pull, two-part line	24,000 pounds	28,000 pounds
Back-crowding line speed per minute	160 feet	172 feet
Rotating speed per minute	3.6 revolutions	4 revolutions
Travel speed per hour	1.0 mile	1.1 mile
Maximum grade empty machine will climb	30%	30%
Operating weight complete	76,000 pounds	85,000 pounds

Chemical Concern's Expansion Interests Waterworks Industry

John R. Mudge, Well Known in Hydraulic Circles, Plays Prominent Part in Company's Plans

Among the developments of the last month in western waterworks circles was an announcement by the Chemical Equipment Corporation, of Los Angeles, of a program of re-organization and expansion.

The company, according to the announcement, has completed selling arrangements with a number of eastern and western manufacturers of equipment such as used by the waterworks and allied hydraulic fields. Associated with the concern is John R. Mudge, who has just returned from an extended trip to points east, where he negotiated several arrangements on behalf of the company, and will personally, in the future, act as western branch manager for the Badger Meter Manufacturing Company of Milwaukee, Wisconsin.

Mr. Mudge is well known to the waterworks industry of the west, having been interested primarily in the water rectification and purification field for a number of years. In his new position he will have charge of the sales and distribution along the west coast of all Badger Meter Company products, which include the well known Badger meters, both of the compound and turbine types, the Badger Electric Alarm Register, the Vogt Brothers Valves and fire hydrants, and their accompanying line of Reilley steam pumps and specialties.

See Big Meter Business

"The Badger Meter Manufacturing

Company has been placing upon the market for a number of years a meter designed for the continuous service demanded by the waterworks industry," said Mr. Mudge, in discussing the new arrangements. "The recent tests by the city of Chicago were very favorable to the Badger Meter, and we anticipate a large volume of business here in the west. The frost proof model, which is built for the colder climates, has the standard oil-enclosed gear train, and is equipped with breakable bottom plates, which, in the event of freezing, give way with the expansion of the ice, and relieve the working parts of the abnormal pressure. There is no breakage of the meter other than the breaking of the bottom plate. The other model, type 'SC,' which is made for the warmer climates, and in places where there is no danger of freezing, is made with all-bronze housing, and the usual refinements characteristic of this type of equipment, including oil enclosed gear train and monel equipped.

"The Badger Electric Alarm is built for installations where a predetermined volume of water is required. The alarm automatically warns the operator so that the flow may be shut off when the desired amount has passed into the system. This is regarded an ideal register for use with water softener installations. The register is upright, open faced, covered with a case or hood which protects the instrument from the elements."

Other Lines to Be Added

The Chemical Equipment Corporation states that only a preliminary announcement of its expansion program can be made at this time. Several other lines of equipment, however, will be included in the waterworks "group," which will embrace non-competitive products of many types, such as water-softeners, pumps, valves, chlorinating and filtration apparatus, meters, recorders, etc.

In addition to Mr. Mudge, who is retained as consulting engineer, the Chemical Equipment Corporation is composed of the following men, who are either actively or financially interested in the concern: Emmett H. Jones, president of Jones-Thorne Company; E. L. Wilson, who continues as secretary of the company; and A. LoPrest, well known in the chlorination field in California. Several other well known engineers have been retained in a consulting capacity.

Mexican Irrigation Progress

A contract has been signed between the Mexican National Irrigation Commission and the J. G. White Engineering Corporation, according to a recent report from Mexico City, for the construction of large irrigation works on the Rio Salado, forty miles northwest of Rodriquez Tamaulipas.

Gas + Air in an Erie Shovel Means Bigger Production

Power Storage Saves Fuel; Quick Action and Large Output Achieved by Heavy Duty Shovel

Gas + Air to the contractor who owns an Erie shovel means bigger production, but to the owners of other shovels it is a mechanical term which merely indicates that the Erie shovel is designed with a combination of gasoline and air principle applied as power.

The Erie Steam Shovel Company, at Erie, Pa., had a reason for the combination, to make a shovel that would run shoulder to shoulder with the steam machine that has earned fame everywhere. This steam record means something with over 4200 machines in service.

In the southwestern part of the country the Gas + Air machine is extremely economical because of the shortage of coal. Power storage is a saving of fuel. Whenever full power of a Gas + Air Erie gasoline motor is not needed for hoisting the dipper or traveling, the gas motor operates the air compressor and stores up air until the storage tanks reach maximum pressure. This storage of power makes the big difference that you see in a shovel's speed and digging power, besides giving a lower fuel cost per cubic yard.

A Good Digger

The Gas + Air Erie has more digging power than one would expect. Its powerful four-cylinder Waukesha engine, with cylinders 5¾" by 8", drives the hoist drum direct through a silent chain drivee. Instead of stealing power from the hoist, the air engine adds extra power for swinging and crowding. The stored up enery of the compressed air is added to the energy of the gas engine.

The synchronization of operation produces quick positive action. The dipper racks into position faster to start the digging stroke. The swing to dump begins as soon as the dipper is full. While still hoisting it stops instantly in a dumping position, also swings back when dumped instantly. The operator has nothing to handle but three throttle levers and a foot brake. The whole cycle of action is smooth and continuous, instead of a series of jerky stops and starts.

On excavating work the quick positive action of the Gas + Air Erie has given 30' to 40' larger output than clutch driven gas shovels of the same dipper size, at a far lower cost per cubic yard. The three engine drive has given it great power to dig hard materials. It handles unblasted shale in a way that amazes contractors. This shovel is reliable because of heavy duty construction.

The Erie service goes everywheree, and a factory engineer is available at all times. Erecting engineers can also be obtained at office of the local distributors, the Concrete Machinery & Supply Company, Los Angeles, known in the circles of engineers and contractors for high quality labor saving machinery and feature service.

Irrigation District Installs Bay City Tractor Shovel

Excavating Company's New Introduction Is All-Purpose Machine With Latest Improvements

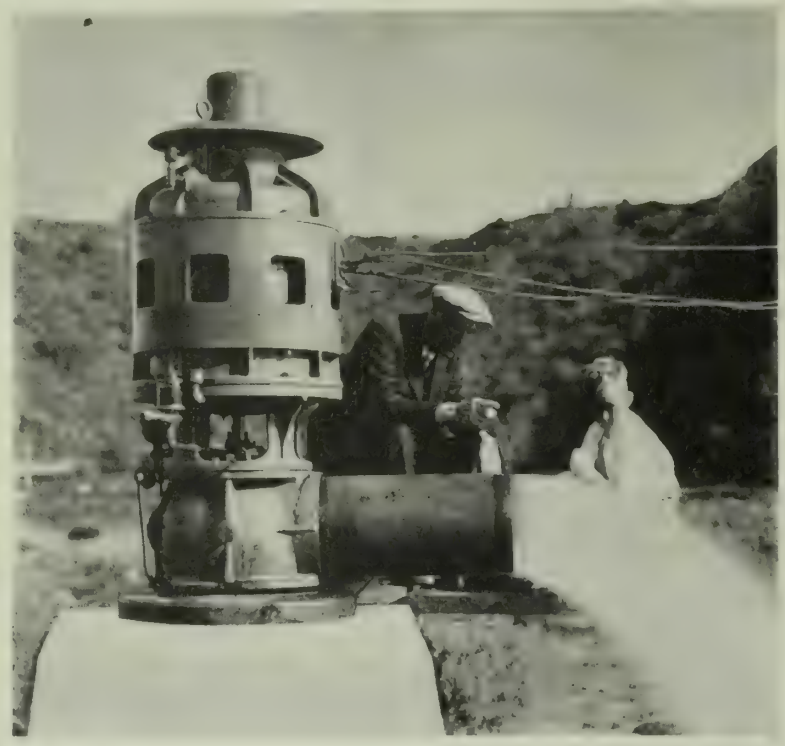
The Truckee-Carson Irrigation District of Fallon, Nevada, has recently installed a Bay City Tractor Shovel, equipped for dragline work for the purpose of cleaning ditches, and incidentally digging some new laterals. This is the first installation of its kind west of the Rocky Mountains, and those concerned are watching the results accomplished by this latest introduction of the Bay City Dredge Works, a company having to its credit a record of a quarter century, building excavating machinery exclusively.

The machine is of a very simple construction, having been designed by J. W. Fairbanks, a man who spent the best years of life in operating various makes and kinds of excavating machines. The power is derived by the installation of the well known McCormick-Deering, International Harvester tractor, and the fact that it is built by the Bay City Dredge Works, should convince the most skeptical as to the merits of the machine in general.

Some good natured joker, taking into consideration the reputation of the three principal factors, the designer, the power plant, and its builder, referred to this machine as "a pup with a pedigree," and in view of the past records of those three factors, the name seems to fit exceptionally well.

The machine is mounted on full length crawlers of the latest design. Its total weight is approximately 18,000 lbs. The caterpillar treads are wide, and so constructed as to enable the machine to turn completely around in its own length on hard ground. It is an all-purpose-machine, designed expressly for light excavating and grading, using shovel bucket, dragline, clamshell, trench hoe, back-filler, and for general light crane service.

One of the most important points in



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favor of this machine is that the boom swings through 270° of the circle, making it possible to dig material, also load it into wagons or trucks standing opposite the rear axle, thus affording full circle service with a three-quarter swing of the boom.

The Bay City Dredge Works line is sold and serviced by its western representative, J. P. Sherbesman, of 1901 Pierce St., San Francisco.

New Concrete Mixer Combines High Speed and Strength

Chain Belt's 28-S Rex Mixer Is Proving Its Worth on Many Big Jobs Now Under Construction

A high speed concrete mixer has been designed by the Chain Belt Company, of Milwaukee, given severe test at the factory and proven itself worthy of its task in the construction field.

Some of the structures on which this 28-S Rex mixer is now working are the Santa Anita Canyon Dam, Grass Valley Dam, Seventy Street Viaduct, Fletcher Drive Bridge, Pico Viaduct, Los Angeles City Hall and the Riverside-Dayton Avenue Bridge, as well as forming the central mixing plant at several locations.

The 28-S Rex mixing drum is big, being 70½" inside diameter by 55" inside, with large discharging and charging openings. The extra large blades grab the aggregate as fast as it comes in, and the deep wide buckets turn the charge into a fury of concrete. The discharge chute with its fast action charges into the drum, and guides the batch to its destination. This operation takes only two revolutions of the drum to entirely clean the mixer. The cycle of operation is made possible by fool proof operations.

Other Features Described

First, the batch hopper is well over capacity with 52° angle and no choke corners, and holds 56 cu. ft. of dry material. The batch hopper gate is simple and positive with a counter-balance operating lever, which requires very little of a man's strength.

Second, chain drive is the proved Rex feature, revolving the drum at 15½ revolutions per minute. It is possible to turn the drum at a high speed with low friction loss or wear because of the chilled rollers, machine ground to exact dimension and mounted on Hyall roller bearings.

The Rex discharge is a dependable mechanism which works automatically. The operator simply touches the lever, and the big charging arms begin to work. The power does the rest. This discharge mechanism consists of a chrome

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nickel jaw clutch together with a vanadium bronze gear. The improved accurate automatic water control discharges twenty-five gallons into the drum in six to eight seconds. The control is set but once to the exact amount required for the batch, and uniform consistency is assured without further attention.

Central Control

From the operating platform, located at the central control point, the operator has all levers at his finger tips, and is in plain view to co-ordinate other operations of the plant with the mixer. The platform is supported by structural steel members, which extend up from the large channel base of structural steel.

Over all dimensions have been economically maintained for a large mixer, and the engineers of the Concrete Machinery and Supply Company, Los Angeles, will be glad to supply anyone interested with the required information and specifications. Their experience in designing plants and choosing the right-sized equipment for the job will be of value to those seeking high speed production with low maintenance.

Notes on the Waterproofing of Concrete Storage Reservoirs

Letter from Waterproof Paint Company States That Most Leaks Occur Through Contraction Joints

The Waterproof Paint Company, of Lankershim, California, has addressed the following letter to Modern Irrigation:

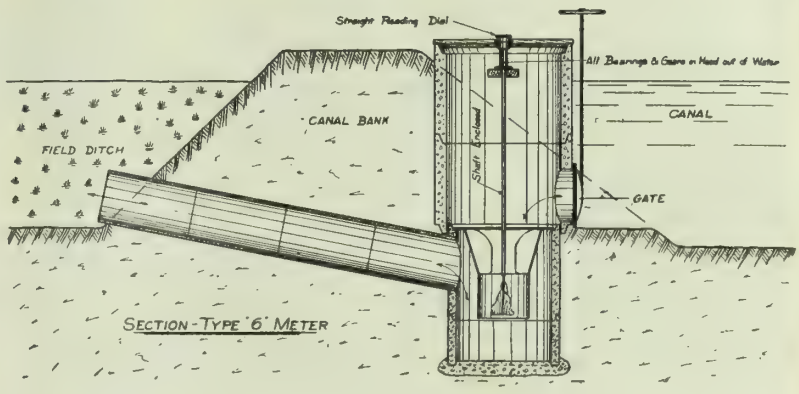
In regard to the waterproofing of concrete structures, particularly hydraulic dams, you will find in the 1926 Year Book, published by the American Society of Civil Engineers, notes pertaining to the failure or partial failure of the Gem Lake dam. It will be noted that those who discussed the conditions seemed to be rather hazy on the subject of waterproofing multiple arch dams. The synopsis of the paper read on this subject was as follows:

"This paper is submitted for the purpose of calling the attention of engineers to the necessity of giving serious consideration to the action of frost when designing dams for use in cold climates. The writers believe that deterioration from frost action will occur in any thin concrete structure subjected to water pressure and extreme cold unless the concrete can be made 100 per cent waterproof (or water tight). . . .

"The results of frost action, therefore, have been pointed out in this paper, together with the expensive repairs necessary to safeguard the structure, and it is hoped the discussion will develop some positive and permanent method of waterproofing concrete."

From experience gained through waterproofing many hundreds of concrete

The RELIANCE METER



THE "Type 6" Reliance Irrigation Meter offers you standardized permanent construction at a very low first cost. Their sustained efficiency with a minimum of upkeep has been proven by 12 years usage. Cut shows installation of the 4 sec. ft. size in 24 and 30-inch concrete pipe. This is the standard type of setting adopted by many irrigation districts in Texas and elsewhere who are now equipping all their deliveries with this device. The "Type 6" meter is furnished in sizes ranging from ½ up to 16 sec. ft.

For further information and prices write—

RANDALL CONTROL & HYDROMETRIC CORP.
1014 E. Ninth St., Los Angeles, Calif.

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No other construction to equal it! Prevents Shaft whipping and insures a rigid smooth operating job.

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Patents Pending

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storage reservoirs, it is our opinion that in very few cases has the concrete itself —the slabs or pavements—leaked any water. The damage has been caused by leakage through contraction joints, which quickly softens the fill and creates fractures. The water spouting through these new fractures causes hundreds of feet of additional cracks, and so on, until the work is undermined and the pavement and the walls deflected with fractures.

Effect of Temperature

In the case of multiple arch dams the greater part of the work is as a rule done in the summer months when the concrete is expanded to the utmost. As winter comes on and cold water is banked against the work, contraction sets in and there is doubtless a bulk movement of the structure itself, due to water pressure. In this case construction joints may open up, contraction joints (if any) move about, and unless provisions has been made for sealing such points against water percolation, something is likely to happen to both downstream and upstream sides as the water recedes.

It is our belief that a great amount of leakage can be eliminated if water-tight contraction joints are placed on close instead of wide centers, and if every construction joint is made into a false or dummy joint for receiving some ductile waterproof compound. In case water does percolate into the concrete after such provisions have been made for bulk movement, and if such waterproofings are watertight, then it is only a question of the selection of the best water resistant coatings for the face of such work. Too much confidence, however, should not be placed in resilient coatings over defective contraction and construction points. Such points must be provided for individually, as their movement is too great for paints to be depended upon.

There is practically no paint that will withstand a water pressure of 100 pounds per square inch for 24 hours—though of course on the ordinary dam there is no such pressure to contend with. The best way to find out about water resistant coatings is to submit them to some reliable tester equipped to make thorough tests. After a coating has made a good laboratory showing, the most important thing for an engineer to know is its wearing quality. We have invented a process for determining this, which we shall be glad to send to any interested engineer.

A few years ago we waterproofed a reservoir for a city in central Wyoming. A temperature drop from 40 above zero to 35 below in 12 hours caught them

with six inches of water in one of the watered sections of the reservoir. This spalled the floor and shoved the sloping walls from line. We also observed that the hot coating that had been applied on portions of their vertical walls as a waterproofing means had attached itself to the ice and upon the lowering of the water this lining was removed with the ice. Ice would very likely do the same thing to an unprotected waterproof membrane, especially one not tightly bonded to the concrete.

If we were designing engineers, we should draw up specifications for membrane waterproofing, supposed to be laid between courses of concrete to prevent abrasion, somewhat as follows: "The membranes attached to the concrete shall be so tightly bonded to the concrete that removal by hand shall be almost impossible. If such removal shows any naked concrete, the work shall be done over. Upon the completion of the application of the membrane, the engineer shall have the privilege of cutting a square foot or so from the membrane at any point, and if inspection shows that the fabrics are not 100 per cent bonded, the work shall be rejected and done over." It is useless for any city to pay for a membrane system that is not tightly and uniformly bonded.

Provision should also be made in the plans that any *poured* concrete, used as a blanket coating over the fabrics, be tightly bonded to the membranes. Such is not the case at the present time. It is our opinion that when Guniting is used as a blanket coating such provision would be unnecessary, provided the hot compounds are fairly soft in composition.

Respectfully,
Waterproof Paint Company,
Lankershim, California.

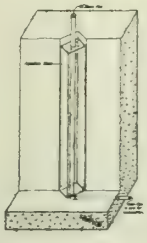
Machinery Houses Combine

Smith Booth Usher Company has recently purchased the Southern California branch of the Edward R. Baker Company, operating in Los Angeles as Contractors Equipment Corporation, and will now handle the many nationally known lines of construction equipment that have been heretofore handled by the latter company.

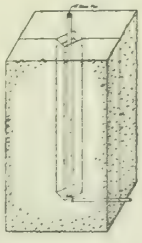
This purchase rounds out for the Smith Booth Usher Company a complete line of industrial, construction and road-making machinery, general or special catalogs of which will be sent on application. With increased facilities of stock, floor display, shipping and service shop, the company is prepared to give the best of service and extends a cordial invitation to those interested to come in and inspect the new lines.

SMITH
PERMANENT
WATER STOP
Patent No. 1,359,283

Cushman Dam, Skokomish River, Washington. Ht. 270 ft.; span 447. Constant angle arch with Smith Permanent Water Stops.



Consists of a plastic packing liquified by the application of heat. The seal may be renewed at any time in the life of the structure simply by the application of heat.



The diagrams show the column of asphalt placed in the joint. A steam pipe or electric wires heat and melt the asphalt, forcing it into each minute crack. Thus at any later date, the asphalt may be reheated and the joint once more made effective.

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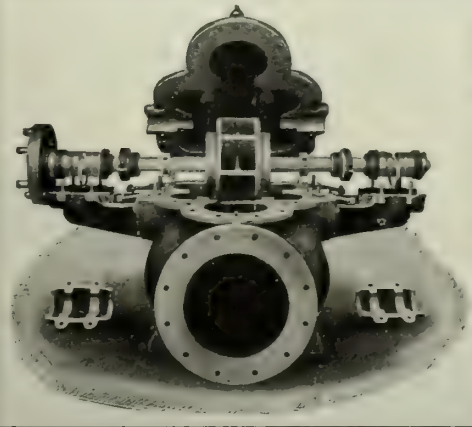

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CONCRETE AND MASONRY DAMS

Name of Dam	River	State	Primary Purpose	Year Completed	Type of Structure	Width At Top Ft.	Width At Base Ft.	Height Feet Above Foundation	Height Feet Above	St. Bed Length of Crest Ft.	Capacity of Reservoir Acre Ft.	Contents of Dam Cu. Yds.	Cost Dollars	Designers of Dam
Arrowrock	Boise	Idaho	Irrigation	1916	Arch Gravity	15½	238	349	251	1,100	280,000	585,130		A. J. Wiley
Ashakan	Esopus	New York	Water Supply	1911	Gravity	26	190	252	150	1,000	368,000	390,000	32,000,000	
Barrett	Cottonwood	Calif.	Water Supply	1922	Arch Gravity	15	167	183½	170	750	29,600			
Basin Creek	Basin	Mont.	Water Supply	1895	Arch Gravity			88	60	259		11,500		C. B. Davis
Bear Valley	Santa Ana	Calif.	Power	1884	Arch Gravity	2½		64		300	50,000	3,400		F. E. Brown
												170,000 con.		
American Falls	Snake	Idaho	Irrigation	1926	Earth and Concrete		75	95	83	5,227	1,700,000	150,000 earth	8,500,000	U. S. B. R.
Bucks Creek	Bucks Creek	Calif.	Power	1927	Arch Gravity				93		6,000			
Boyds Corner	Croton W.	N. Y.	Water Supply	1872	Gravity	9	57	78	57	670	8,400	27,000		Geo. S. Greene
Booton	Rockaway	N. J.	Water Supply	1905	Cycl. Gravity	17	64	105	71	3,150		255,000		E. W. Harrison
Black Canyon	Payette	Idaho	Irrigation	1924	Gravity			183		1,040		79,844		
Burton	Tallulah	Ga.	Power	1920	Gravity			116		1,250				
Alpine	Marine Co.	Calif.	Water Supply		Gravity	78	465		108		4,600			J. D. Schuyler
Catawba		S. C.	Power	1904	Earth and Concrete		33			585		60,000 con.		
Crawley Creek		Ore.	Power	1914	Const. Rad. Arch	3	32	70		170	1,000			
Checah	Little Tennessee	N. C.	Power	1919	Arch Gravity			200	180	700				
Croton Falls	Croton	N. Y.	Water Supply	1911	Gravity	23	128	167	113	1,100		245,000	4,200,000	W. H. Sears
Cross River	Croton	N. Y.	Water Supply	1908	Gravity	23	116	170	135	772		155,000		
Coolidge	Gila	Ariz.	Irrigation		Multiple Dome				250	560	1,300,000	191,000	2,270,000	C. R. Oldberg
Don Pedro	Tuolomne	Calif.	Irrigation	1923	Arch Gravity	16	176	284	260	1,040	290,000	270,000	10,000,000	A. J. Wiley
Devils Gate	Arroyo Seco	Calif.	Flood Control	1920	Arch Gravity	30	99	130	100	310				
East Park	Stony Creek	Calif.	Irrigation	1911	Arch Gravity			139		250	51,000	12,200		
Elephant Butte	Rio Grande	New Mex.	Irrigation	1916	Arch Gravity	18	215	308	240	1,674	2,638,000	605,200	5,000,000	L. C. Hill
Exchequer	Merced	Calif.	Irrigation	1926	Arch Gravity	12	228	330	324	943	278,000	374,000		A. J. Wiley
Folsom	American	Calif.	Power	1891	Gravity Weir	24	87	98	68	650		48,500		State Engineer
Granite Springs	Crow Creek	Wyo.	Water Supply	1904	Arch Gravity	10	56	96	90	410	5,300	14,400	109,200	A. J. Wiley
Gibraltar	Santa Inez	Calif.		1919	Arch Semi Gravity	8	65	185	160	1,100	140,000	160,000	1,600,000	L. C. Hill
Gibson	Sun	Mont.	Irrigation		Arch Gravity	15	87	195						
Glines Canyon	Elwah	Wash.	Power	1927	Arch Semi Gravity	4	27½	200	180	155	43,000	16,630		H. Schorer, etc.
Huntington Lake 1	Big Creek	Calif.	Power	1912	Arch Gravity	6	102	165	155	1,320				
Hemet	San Jacinto	Calif.	Irrigation	1895	Arch Gravity	10	100	135	125	280	10,500			
Hemet	San Jacinto	Calif.	Irrigation	1895	Arch Gravity	30	100	136	110	280		31,100		
Hauser Lake	Missouri	Mont.	Power	1912	Gravity		96	132	110	600		83,000		
Halligan	Cache La Poudre	Colo.	Power	1910	Const. Rad. Arch	6		94		350	6,400			
Kensico	Bronx	N. Y.	Water Supply	1916	Gravity	28	235	307	294	1,843		900,000		
Lake Cheeseman	S. Platte	Colo.	Water Supply	1904	Arch Gravity	18	176	236	227	710	80,000	103,000	1,000,000	C. L. Harrison
Lower Otay	Otay	Calif.	Water Supply	1919	Arch Gravity	15	150	175	149	750	45,200			
Lock Raven	Gunpowder	Md.	Water Supply	1913	Gravity	10	60	52	35	650		56,500	527,425	
Lock Raven (raised)	Gunpowder	Md.	Water Supply	1922	Gravity	13	60	104	97	650	70,600	96,445	1,121,076	H. G. Perring
Lock No. 12	Coosa	Ala.	Power	1915	Gravity			56		1,638				
Morgan Falls	Chattahooche	Ga.	Power	1904	Gravity	64		50		900				G. B. Francis
McCalls Ferry	Susquehanna	Pa.	Power		Gravity	65		55		2,300		330,000		C. T. Hutchison
Mathis	Tallulah	Ga.	Power		Gravity			90		700	30,000	1,376,000		
Martin	Tallapoosa	Ala.	Power	1926	Arch Gravity			164						
Melones	Stanislaus	Calif.	Irrigation	1926	Arch Gravity	10		210	185	590	112,500	91,000	772,000	A. J. Wiley
Mitchell	Coosa	Ala.	Power	1923	Gravity			55		1,200		202,000		
Medina	Medina	Tex.	Flood Control	1913	Gravity	25	128	178	164	1,580				
Mulholland	Wied-Canyon	Calif.	Water Supply	1925	Arch Gravity	16	155	204	180	890	8,000	173,462		
New Croton	Croton	N. Y.	Water Supply	1907	Gravity	18	296	297	166	1,168	180,000	855,000	7,631,000	Alphonse Fteley
Nederland	Boulder	Colo.	Water Supply	1909	Gravity	16	124	172	145					
Oak Grove	Oak Grove Cr.	Ore.	Power	1925	Gravity				68	180				
Pedlar	Pedlar	Va.	Water Supply	1905	Gravity	10	40	74		415	1,115		104,000	H. L. Shaner
Pathfinder	N. Platte	Wyo.	Irrigation	1909	Gravity Arch	10	94	210	204	425	1,070,000	60,210	500,000	D. C. Henny
O'Shaughnessy	Tuolumne	Calif.	Water Supply	1923	Gravity Arch	15	298	334	227	605	200,000	398,516	6,647,000	
O'Shaughnessy	Tuolumne	Calif.	Water Supply		Gravity Arch	25		430	313	900	350,000	660,000		
Roosevelt	Salt	Ariz.	Irrigation	1911	Gravity Arch	16	170	284	262	1,125	1,637,300	342,325		L. C. Hill and F. Teichman

NOTE Data in these tables of dams have been collected from a great many sources and every effort made to insure their correctness, but the publishers of MODERN IRRIGATION cannot guarantee their accuracy. Suggestions and criticisms are invited.

CONCRETE AND MASONRY DAMS—Continued

Name of Dam	River	State	Primary Purpose	Year Completed	Type of Structure	Width At Top Ft.	Width At Base Ft.	Height Feet Above Foundation	Height Feet Above	St. Bed Length of Crest Ft.	Capacity of Reservoir Acre Ft.	Contents of Dam Cu. Yds.	Cost Dollars	Designers of Dam
Round Hill	Spring Creek	Pa.	Water Supply	1901	Earth and Concrete	9	78	114		220	4,050	37,700	240,600	John Lance
Remmel	Ouachita	Ark.	Power	1924	Ambursen			75		900		30,000	2,000,000	
Shannon	Baker	Wash.	Irrigation	1926	Arch Semi Gravity	20	180	263	220	450	120,000	115,000		W. D. Shannon
Rush Meadow		Calif.	Power	1925	Arch Gravity	2½		55	40	464	4,970			
Seligman		Ariz.	Water Supply	1898	Gravity	2	48	68		643	703	18,161	150,000	
Sodom	E. Croton	N. Y.	Water Supply	1893	Gravity	12	53	98	78	500	15,000	35,900	366,500	A. Fteley
Sweetwater	Sweetwater Cr.	Calif.	Water Supply	1916	Arch Gravity	12	76	129	108	380				J. D. Schuyler {1888 1911 1916
Sun River	Sun River	Mont.	Irrigation		Gravity			132		212		6,200		
Spier Falls	Hudson	N. Y.	Water Supply	1905	Gravity	17	113	154		552		180,000		C. F. Parsons
San Mateo	San Mateo Cr.	Calif.	Water Supply	1888	Arch Gravity	25	176	162	146	680	85,000	139,000		
Salmon River	Salmon	Idaho	Irrigation	1912	Const. Rad. Arch	12		220		490	228,000			
Shoshone	Shoshone	Wyo.	Irrigation	1910	Gravity Arch	10	108	328	243	200	456,600	78,600		D. C. Henny and H. N. Savage
St. Francis	S. F. Canyon	Calif.	Water Supply	1926	Gravity Arch		169	205	175	650	38,000	175,000		
Titicus	Titicus	N. Y.	Water Supply	1895	Gravity	21	81	135	109	534				A. Fteley
Tallulah	Tallulah	Ga.	Power		Gravity			116		400				
Pit River No. 3	Pit	Calif.	Power	1925	Arch Gravity	12	107	112		500	36,000			
Upper Otay	Otay	Calif.	Water Supply	1900	Arch Gravity	4	16	84	79¾	350	26,000			
Willwood	Shoshone	Wyo.	Irrigation		Weir			70		320				
Walnut Canyon	Walnut	Ariz.	Water Supply		Gravity		62	77	50	268	488	7,000		
Warm Springs	Malheur	Ore.	Power	1920	Const. Rad. Arch	8	28	107		470	170,000			
Wigwam	Naugatuck	Conn.	Water Supply	1903	Gravity	12	62	91	87	632	1,028	14,900	150,000	R. A. Cairns
Wachusetts	Nashua	Mass.	Water Supply	1906	Gravity	22½	187	228	145	850	193,300	266,700	11,000,000	F. P. Stearns
Yadkin	Yadkin	N. C.	Power	1919	Gravity Arch			190	169	1,400		525,000		
Lake Spaulding	S. Yuba	Calif.	Power	1916	Const. Angle Arch	11	186	295	275	800	74,500	192,000		Con. Angle Arch Co.
Lake Cushman		Wash.	Power	1926	Const. Angle Arch	8	46	280	250	340	450,000	85,000		Con. Angle Arch Co.
Copco No. 1	Klamath	Ore.	Power	1922	Const. Angle Arch	30	95	257		420				Con. Angle Arch Co.
Mormon Flat	Salt	Ariz.	Irrigation	1924	Const. Angle Arch			229		619	63,200	43,500		Con. Angle Arch Co.
Santeelah	Tallassee	Pa.	Power		Const. Angle Arch	10	48		202	340				Con. Angle Arch Co.
Bullards Bar	Yuba	Calif.	Power	1923	Const. Angle Arch	8	43	188	181	440	11,000			Con. Angle Arch Co.
Canyon Creek	Canyon Cr.	Utah	Power	1917	Const. Angle Arch			140		400				Con. Angle Arch Co.
Salmon Creek	Salmon	Alaska	Power	1913	Const. Angle Arch	6	48	168		545		52,000		Con. Angle Arch Co.
Upper Hubbard	Hubbard	Mont.	Power	1923	Const. Angle Arch	5	22	131		400		17,000		Con. Angle Arch Co.
Lost Creek	Lost Creek	Calif.	Power		Const. Angle Arch	4	23½	112	97	360	5,750	11,000	185,000	Con. Angle Arch Co.
Emigrant Creek		Ore.	Power	1924	Const. Angle Arch	5	19	115		360				Con. Angle Arch Co.
Kerckhoff	San Joaquin	Calif.	Power	1920		16	36	91	83	495		23,000		
Clear Creek		Wash.	Irrigation	1913				90		180				
Carmel	Carmel	Calif.	Water Supply	1920	Const. Angle Arch	5	16	90		270				
Concow	Concow	Calif.	Irrigation	1924	Const. Angle Arch	4	19	90		275	8,200			
Gerber	Miller	Ore.	Irrigation	1925	Const. Angle Arch	5	18	85	73	478	94,000	11,888		
Palmdale		Calif.	Irrigation	1924	Multiple Arch	1¼	3	175		724	5,000			
Lake Hodges	San Dieguito	Calif.	Water Supply	1920	Multiple Arch	1	2½	150	130	558	28,400			
Florence Lake	San Joaquin	Calif.	Power	1926	Multiple Arch			149		3,160	60,000	57,500		
Gem Lake	Rush Creek	Calif.	Power	1917	Multiple Arch	1	4	112		700		8,500		
Murray		Calif.		1918	Multiple Arch	1	2½	117		900	6,750	121,788		J. S. Eastwood
Mountain Dell		Utah		1917	Multiple Arch	1¼	4	110						
Cave Creek	Salt	Ariz.	Flood Control		Multiple Arch			107		1,732	14,000	18,700		
Bear Valley		Calif.	Power	1911	Multiple Arch	1	2¼	91½		363				
Lake Eleanor		Calif.	Water Supply	1918	Multiple Arch			70	70	1,260	27,800	11,600		M. M. O'Shaughnessy
San Dieguito	San Dieguito	Calif.	Water Supply		Multiple Arch			62		600				
Los Verjelo		Calif.			Multiple Arch			60						
Garoga		N. Y.			Multiple Arch	2	4	60						
Pecks Lake		N. Y.			Multiple Arch			55						
La Prele		Wyo.	Irrigation	1909	Ambursen			....	135	250		15,000		

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CONCRETE AND MASONRY DAMS—Continued

Name of Dam	River	State	Primary Purpose	Year Completed	Type of Structure	Width At Top Ft.	Width At Base Ft.	Height Feet Above Foundation	Height Feet Above	St. Bed Depth of Crest Ft.	Capacity of Reservoir Acre Ft.	Contents of Dam Cu. Yds.	Cost Dollars	Designers of Dam
Jordan River	Jordan	Canada	Power	1912	Ambursen			126	....	756		21,200		
Ellsworth	Union	Maine	Power	1908	Ambursen			72	72	500	71,000	8,000		
Patapsco	Patapsco	Md.	Power		Ambursen			....	30	200		2,200		
Juniata	Juniata	Pa.	Power	1906	Ambursen			....	28	460		6,400		
Pittsfield		Mass.	Power	1908	Ambursen			....	42	465		3,950		
La Grange	Tuolumne	Calif.	Power	1894	Gravity Weir	24	88	129	125	310		39,500		Luther Wagoner
Ithaca	Six Mile Cr.	N. Y.	Water Supply	1903	Arch Sphere	2½	14½	36	31	67				G. S. Williams
Hume	LongMeadowCr.	Calif.	Water Supply	1918	Multiple Arch	12 arch	50-span	61	57	677			46,000	J. S. Eastwood
Santa Anita	Santa Anita	Calif.	Flood Control	1927	Const. Angle Arch			225				60,000		
East Park	Stony Cr.	Calif.	Irrigation								51,000			
Morris	James Cr.	Calif.	Irrigation	1917	Gravity Arch	3	8½	51	40	107				Edward Morris
Copco No. 2	Klamath	Calif.	Power	1925	Arch Gravity	14	31	49	34	186				
Agnew Lake	Rush Cr.	Calif.	Power	1915	Multiple Arch			41	30	278				
Rock Creek	Rock Cr.	Calif.	Power	1916	Multiple Arch	1.17	1.42	36		1,080				
Old Mission	San Diego	Calif.	Water Supply	1870	Gravity	13	13	18	15	244				
Williams	Williams	Ariz.	Water Supply	1894	Gravity Curved	4	32	46		385	338	5,226	53,000	
De Weese	Grape	Colo.	Irrigation	1905	Gravity Curved			44			1,700			
Lost River		Ore.	Irrigation	1915	Gravity-reinforced			40		290				
Mt. Tabor No. 1		Ore.	Water Supply	1894	Gravity	6	18		35	300				J. D. Schuyler
Mt. Tabor No. 3		Ore.	Water Supply	1894	Gravity	15½	40		60	200				J. D. Schuyler
Mt. Tabor No. 4		Ore.	Water Supply	1894	Gravity		40		50	350				J. D. Schuyler
Triphammer Falls		N. Y.	Experimental	1897	Arch Gravity			30		153				
Bridgeport	Fall Cr.	Conn.	Water Supply	1886	Gravity	8	32	43		640	737			
Trap Falls	Trap Cr.	Conn.	Water Supply	1905	Gravity	8		48		900	4,340			
Connellsville	Trap Cr.	Conn.	Water Supply	1906	Gravity	6	26	39	28	650				J. W. Ledoux
Quayabal		Porto Rico	Water Supply		Ambursen			127						

For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Page 102

DAMS NOW UNDER CONSTRUCTION

Name of Dam	River	State	Primary Purpose	Year Completed	Type of Structure	Width At Top Ft.	Width At Base Ft.	Height Feet Above Foundation	Height Feet Above St. Bed	Length of Crest Ft.	Capacity of Reservoir Acre Ft.	Contents of Dam Cu. Yds.	Cost Dollars	Designers of Dam
Bull Run	Bull Run	Ore.	Water Supply	1928	Arch Gravity	18	142	200	180	935	32,000	230,000	3,000,000	D. C. Henny
Sawpit		Calif.	Flood Control	1927	Const. Rad. Arch			265	160		350	42,300	241,000	
Wilson	Tennessee	Ala.	Power	1928	Gravity			95				1,440,000		
San Gabriel	San Gabriel	Calif.	Flood Control	1932	Arch Gravity	30	360	438	375	2,200	200,000	3,260,000	25,000,000	W. E. Fisher
Stony Gorge	Stony Creek	Calif.	Irrigation	1928	Ambursen			152	120	1,000				Ambursen
Gibson	Sun	Mont.	Irrigation	1929	Arch Gravity			227	200	900	105,000		3,000,000	J. L. Savage
Coolidge	Gila	Ariz.	Irrigation	1928	Multiple Dome				250	560	1,300,000	191,000	5,000,000	C. R. Oldberg
Pacoima	Pacoima	Calif.	Flood Control	1927	Const. Angle Arch	8	96	400	375	540	12,000	151,000	1,720,000	
Horse Mesa	Salt	Ariz.	Irrigation	1927	Const. Angle Arch			305	287	784	245,000	350,000	4,743,000	J. C. Cragin
Bluewater-Toltec	Bluewater	New Mex.	Irrigation	1927	Arch Gravity	5		109	97	340	53,000		350,000	V. L. Sullivan
Big Santa Anita	Santa Anita	Calif.	Flood Control	1927	Const. Angle Arch	7	41	225	.....	460	1,500	60,300	600,000	
Grizzly Forebay	Grizzly Creek	Calif.	Power	1928	Const. Angle Arch	6	22		88	420	1,200	11,000		
Bucks Creek	Bucks	Calif.	Power	1927	Const. Angle Arch	6	27	96		420				
Sutherland	Santa Ysabel	Calif.	Water Supply	1928	Multiple Arch			180	160	780	21,200			
Lake Pleasant	Agua Fria	Ariz.	Irrigation	1928	Multiple Arch			201	170	1,850	173,500			C. E. Griggs
Shaver Lake	Stevenson Cr.	Calif.	Power	1927	Gravity	31	121	185	164	2,105	138,570	275,000		J. C. Cragin
Thompson Creek	Thompson	Calif.			Earth Fill							310,000		
Big Dalton					Rock Fill									
Puddingstone			Flood Control		Earth Fill							1,600,000		
Shasta River	Shasta	Calif.	Irrigation	1928	Hydraulic Fill							700,000	353,000	J. A. Beemer
McKay	Umatilla	Ore.	Irrigation	1927	Earth & Rock Fill							2,300,000		J. L. Savage
Gordon	Gordon Cr.	Calif.	Irrigation	1927	Earth Fill	15	.....	104	86	563	10,000			
Lafayette					Earth Fill	30	.....	170		1,855				

PROPOSED DAMS

Name of Dam	River	State	Primary Purpose	Year Completed	Type of Structure	Width At Top Ft.	Width At Base Ft.	Height Feet Above Foundation	Height Feet Above St. Bed	Length of Crest Ft.	Capacity of Reservoir Acre Ft.	Contents of Dam Cu. Yds.	Cost Dollars	Designers of Dam
Echo	Weber	Utah	Irrigation	1929	Earth & Rock Fill				125		74,000	1,400,000	3,000,000	E. O. Larson
Owyhee	Owyhee	Wash.	Irrigation	1931	Arch Gravity	.....	.....	.....	360				6,000,000	
Deadwood	Deadwood	Idaho	Irrigation	1930	Arch Gravity	.....	.....	.....	100				1,100,000	
Weber	Weber	Idaho	Irrigation	1930	Earth Fill	.....	.....	.....	125	1,800			2,000,000	
Ripraps	Skagit	Wash.	Power	1931	Const. Angle Arch			555	515	2,000	2,550,000			
Diablo	Skagit	Wash.	Power	1929	Ambursen				295	880	90,000	260,000		
Boulder Canyon	Colorado	Ariz.	Flood Control	1937	Rock Fill			680	560		26,000,000			
Pardee	Mokelumne	Calif.	Water Supply	1930	Arch Gravity			350	340		220,000			
Salt Spring	Mokelumne	Calif.	Power	1929	Rock Fill			300		1,300	130,000	2,500,000		
San Vicente	San Vicente	Calif.	Water Supply	1930	Arch Gravity				160	682	13,000			
Folsom	American	Calif.	Combination	1935	Gravity	10		250	190	3,470	307,000		11,000,000	
Hazel Valley	Sly Park	Calif.	Irrigation	1930	Multiple Arch				140		20,000	20,000		
El Capitan	San Diego	Calif.	Water Supply	1929	Arch Gravity				200	725	24,000			
Stewart Mountain	Salt	Ariz.	Power	1930	Const. Angle Arch				180	1,147	70,000			
Prado	Santa Ana	Calif.	Irrigation	1931	Hydraulic Fill			92	70	1,425	174,000		5,000,000	
Kennett	Sacramento	Calif.	Irrigation		Arch Gravity				420		2,900,000		80,000,000	
Oroville	Feather	Calif.	Irrigation		Arch Gravity				300		345,000		35,000,000	
Narrows	Yuba	Calif.	Irrigation		Arch Gravity				435		445,000		30,000,000	
Parker	Bear	Calif.	Irrigation		Arch Gravity				250		100,000		6,000,000	
Fairview	Trinity	Calif.	Irrigation		Arch Gravity				370		1,400,000		33,000,000	
Temperance Flat	San Joaquin	Calif.	Irrigation		Arch Gravity				595		1,100,000		51,000,000	
Pine Flat	Kings	Calif.	Irrigation		Arch Gravity				450		1,400,000		35,000,000	
Isabella	Kern	Calif.	Irrigation		Arch Gravity				250		1,100,000		27,000,000	
Bakersfield	Kern	Calif.	Irrigation		Arch Gravity				140		200,000		13,000,000	

IMPORTANT FOREIGN DAMS

Name of Dam	River	State	Primary Purpose	Year Completed	Type of Structure	Width At Top Ft.	Width At Base Ft.	Height Feet Above Foundation	Height Feet Above St. Bed	Length of Crest Ft.	Capacity of Reservoir Acre Ft.	Contents of Dam Cu. Yds.	Cost Dollars	Designers
Anyox		Canada	Power	1923	Multiple Arch			140		680				
Ashti		India	Irrigation		Earth Fill	6	182		58	12,709	35,700			
Assuan	Nile	Egypt	Irrigation	1902	Gravity	8	23	96	66	6,400	863,000	704,000	12,250,000	Sir Wm. Wilcocks
Alicante		Spain	Irrigation	1594	Arch Gravity	66	110	135		190	2,982			
Ban	Reservoir	France	Water Supply	1870	Gravity	16	127	157	152	512	475,454,000 gal.		190,000	
Barossa		Australia	Water Supply	1903	Arch Semi Gravity	4½	34	112	95	472	3,675	18,000	827,000	
Betwa	Betwa	India	Irrigation		Gravity	15	62	50	41	3,296	1,603,000,000 cu. ft.			
Blackbrook		England	Water Supply	1905	Gravity	14	65	108	92	525	1,860			
Burrator	Meavy	England	Water Supply	1899	Gravity	12	63	146	106	470	2,410			
Burring Juick	Murrumbidgee	Australia	Water Supply	1914	Arch Gravity	18	168	244	220	784	780,000			
Burraga	Thompson	Australia	Water Supply		Arch Gravity	2	25	41		425	310		44,500	J. H. Cardew
Beetaloo	Gawler	Australia	Water Supply	1890	Arch Gravity	14	110	110	101	580	2,945	60,000	570,000	J. C. Moncrieff
Bhatgur	Yelwand	India	Irrigation	1891	Gravity	12	74	130	107	4,076	5,511,000,000 cu. ft.			A. Hill
Camarassa		Spain		1924	Gravity				338					
Cataract	Cataract River	Australia	Water Supply	1907	Gravity	16½	158	192	157	811	78,900	146,242	1,602,000	L. A. Wade
Cher	Cher	France	Water Supply	1907	Gravity Curved	15	141	154	106	323	6,900,000,000 gal.			
Chartrain	Tache	France	Water Supply	1892	Gravity	21	157	180	164		159,000,000 cu. ft.		2,100,000	
Cagliari	Corrunguis	Italy	Water Supply	1866	Gravity	16½	52½	70½	64	344½	264,141,000 gal.			
Coolgardie	Helena	Australia	Water Supply		Gravity	10	100	197	101		16,900			C. R. Russel
Crocodile	Crocodile	S. Africa	Irrigation	1922	Const. Angle Arch			198		450				W. H. Hall
Coquitlam		Canada	Power	1913	Hydraulic Fill	40	622		94	850		544,700		
Cotatay	Cotatay	France	Water Supply	1904	Arch Gravity	14	62	144	121	508	225,000,000 gal.			M. G. Reuss
Djidionia	Djidionia	Algiers	Water Supply	1875	Gravity	13	38	72	65					
Ekruk		India	Irrigation		Masonry-Earth Fill				76	4,210		76,500	666,000	
Esperanza		Mexico	Water Supply		Gravity	20	76	138		580	16,200	55,000	80,000	Ponciano Aguillar
Einsiedel		Germany	Water Supply	1894	Arch Gravity	13	65½	92	65½	590	95,000,000 gal.	31,600		
Elche	Vinolapo	Spain	Water Supply					76		230				
Furens	Furens	France	Flood Control	1866	Gravity Curved	12½	166	184	171	326	1,297	52,300	320,000	M. Graeff
Gorzente	Gorzente	Italy	Water Supply	1883	Gravity	23	99½	121	107	492	594,500,000 gal.			
Gileppe	Gileppe	Belgium	Water Supply	1876	Gravity Curved	49	216	154	137	771	3,170,000,000 gal.	325,000	874,000	M. Bidaut
Gide	Gide	Sweden	Water Supply	1919	Const. Angle Arch				85					
Gran Cheurfas	Mekerra	Algiers	Irrigation	1884	Gravity		135	134	100		13,000			
Geelong	Stony Creek	Australia	Water Supply		Arch Gravity	2½	39	60						
Gros Bois	Brenne	France	Flood Control	1838	Gravity Weir	21	46	93	73	1,804				
Hijar	Martin	Spain	Irrigation	1880	Gravity	16½	147	141	130	236	8,900			
Hamiz	Hamiz	Algiers	Irrigation	1885	Gravity	16½	91	135	125	532	10,500			
Johannesburg		S. Africa	Water Supply											
Komotau		Australia	Water Supply	1904	Gravity	13	98½	116½	139½	508¼	184,898,700 gal.	46,000		E. Landisch
L'Echapre	L'Echapre	France	Water Supply	1898	Gravity Curved	17	89	121½	115	541	770			M. Reuss
Laguna	Necaxa	Mexico	Power	1907	Hydraulic Fill	25			66					F. S. Hyde
La Jalpa	Lerma	Mexico	Irrigation	1909	Earth Fill	9	66	85		1,800	28,370	92,000	500,000	
La Jogne		Switzerl'd		1921	Const. Angle Arch			186						
Lauchensee		Germany	Flood Control	1895	Arch Gravity	13	65	98		840	624	37,400	243,700	H. Fecht
Lagolungo	Garzente	Italy	Water Supply	1904	Gravity	8	140	141		2,950				
Los Reyes	Necaxa	Mexico	Power		Hydraulic Fill				100					F. S. Hyde
Lozoya	Rio Lozoya	Spain	Irrigation	1850	Gravity	22	128	105	94	238				Government
Luleaa		Sweden		1922	Multiple Arch			60		1,000				
Manila		P. I.	Irrigation	1913	Const. Angle Arch				98					
Mariquina		P. I.	Water Supply	1906	Gravity	17	69		75	400	6,100	28,000		
Mercedes	Zorillo	Mexico	Irrigation	1905	Gravity	11½	84	133	105	535	12,000	28,000		Chas. Patoni
Mezcales	Mayo	Mexico	Irrigation	1930	Multiple Arch				185	3,000				L. C. Hill
Makwar	Blue Nile	Egypt	Irrigation	1926	Earth Fill			108	108	3,270				
Mouche	Mouche	France	Water Supply	1890	Gravity	11½	69	115	107	1,346	306,000,000 cu. ft.			M. Carlier
Montejaque	Gaduares	Spain	Water Supply	1924	Const. Angle Arch	10	55	273	210	256		35,000		

IMPORTANT FOREIGN DAMS—Continued

Name of Dam	River	State	Primary Purpose	Year Completed	Type of Structure	Width At Top Ft.	Width At Base Ft.	Height Feet Above Foundation	Height Feet Above St. Bed	Length of Crest Ft.	Capacity of Reservoir Acre Ft.	Contents of Dam Cu. Yds.	Cost Dollars	Designers of Dam
Massif Central	Creuse	France	Power						190		40,000			
Miodeix	Miodeix	France	Power	1903		10	69	79	72					
Necaxa	Necaxa	Mexico	Power	1909	Earth Fill	54	975	190	185	1,220	34,850	2,143,500		J. D. Schuyler
Nijar	Carrizal	Spain	Water Supply	1850	Gravity	24½	68	102	74		12,570			Geronimo Ros
Ondenon		France	Water Supply	1904	Arch Gravity	14½	86	123	106½	420	106,000,000 gal.			M. G. Reuss
Osmena		P. I.	Water Supply	1913		3¼	13¼	98		100				
Oi		Japan	Power	1925	Gravity				190					Anderton
Patillas		Porto Ricc	Water Supply	1913	Hydraulic Fill	20	572	147	122	1,020		970,000		J. Jackobs
Poona	Mutha	India	Irrigation	1874	Gravity	13½	61	108	98	5,136	90,000	360,000	630,000	Col. Fife
Periyar	Periyar	India	Irrigation	1897	Gravity	12	115	173	155	1,231	305,000	185,000		Col Pennywick
Pas Du Riot	Furens	France	Water Supply	1878	Arch Gravity	12½	108	113	101		340,000,000 gal.		256,000	
Pont	Armacon	France	Water Supply	1883	Arch Gravity	16	62	85	65½	495				
Rio Das Lages	Lages	Brazil	Power	1907	Arch Gravity	13	49	135			178,000			C. H. Kearney
Remscheid	Eschback	Germany	Water Supply	1892	Arch Gravity	13	49	82	74	261	35,310,000 cu. ft.	22,900		O. Intze
Santo Amaro	M'Boy Guassu	Brazil	Power	1908	Hydraulic Fill	49	344		63	5,300	156,600	738,000		J. D. Schuyler
Swansea		Wales	Water Supply	1905	Gravity		75	144	107	1,250				R. H. Wyrill
Solingen		Germany	Water Supply		Arch Gravity	15	120	141		585				
Sioule	Sioule	France	Water Supply	1904	Arch Gravity	16½	79	98½	95	394	661			
Tlelat	Tlelat	Algiers	Irrigation	1869	Gravity	13	41	69	47	325				
Tezcapa	Necaxa	Mexico	Power	.....	Hydraulic Fill				175		15,000			J. D. Schuyler
Tytam	Hong Kong	China	Water Supply	1887	Gravity	19	62	103	95					
Tansa		India	Water Supply	1891	Gravity	15	96½	118	104	8,800	691,000,000 cu. ft.	408,000	1,000,000	J. C. Clarke
Talla	Talla	Scotland	Water Supply	1904	Hydraulic Fill	20			78	1,030				
Turdine	Turdine	France	Water Supply	1904	Arch Gravity	13	65	82	76	394				
Ternay	Ternay	France	Water Supply	1868	Arch Gravity		89	119			1,312	2,107	204,400	M. Bouvier
Thirlmere	Thirlmere L.	England	Water Supply	1893	Gravity Curved	18½	51¾	62	58	176				Geo. H. Hill
Urayama	Urayama	Japan	Water Supply	1921	Gravity	4	9		45					
Urft	Urft	Germany	Irrigation	1904	Arch Gravity	18	165½	190	165½	741	12,000,000,000 gal.			O. Intze
Vyrnwy	Vyrnwy	Wales	Irrigation	1890	Gravity	22	117¾	136	101	1,350	44,690	260,000	3,300,000	G. F. Deacon
Vingeanne		France	Irrigation	1885	Arch Gravity	11½	18	114						
Villar	Lozoya	Spain	Irrigation	1878	Arch Gravity	15	155	170	162	546	13,500		390,000	Jose Morer
Verdon	Verdon	France	Water Supply	1870	Arch Gravity	14	33	59	40	131				M. de Tournadree
Warranga		Australia	Irrigation								333,000			
Yan Yean		Australia	Water Supply								26,000			
Zola		France	Water Supply	1843	Arch Gravity	19	49	120		205				
Avignonet	Drac	France	Power	1902	Gravity Weir	15½	78½	75½	75½	196½				
Bouzey	Epinal	France	Water Supply	1881	Gravity Weir	13	37½	72	49	1,700	1,875,000,000 gal.			Destroyed
Almanza	Albacete	Spain	Irrigation	1586	Gravity Weir	8	34	68	34	292				
Belubula	Belubula	Wales	Power	1898	Gravity	5	12	60	36	431	652,000,000 gal.			Oscar Schultze
Assiout	Nile	Egypt	Irrigation	1903	Gravity Weir	10	87	48	33	2,769				

EARTH AND ROCK FILL DAMS

Name of Dam	River	State	Primary Purpose	Year Completed	Type of Structure	Width At Top Ft.	Width At Base Ft.	Height Feet Above Foundation	Height Feet Above St. Bed	Length of Crest Ft.	Capacity of Reservoir Acre Ft.	Contents of Dam Cu. Yds.	Cost Dollars	Designers of Dam
Athens	Athens	Ga.	Water Supply	1916	Hydraulic Fill	10	260	72	50	1,104				
Apishapa		Colo.	Water Supply	1907	Earth Fill	19	287	120	118					
Bumping Lake	Yakima	Wash.	Irrigation	1909	Earth Fill	12	187	45	41	3,425	34,000	248,000		
Bear River	Bear	Calif.	Power	1900	Rock Fill	13	216	80	80	748				
Buell	Montecito	Calif.	Water Supply	1927	Hydraulic Fill	15	267	132	105	550	138	137,000	142,000	Leeds & Barnard
Butt Valley	Butt Creek	Calif.	Power	1917	Hydraulic Fill	25	315	91	80	1,200	50,000	300,000		J. D. Schuyler
Big Meadows	Feather	Calif.	Power	1926	Rock & Hyd. Fill	75	1,300	125	117	1,297	1,300,000	1,280,000		J. M. Howells
Bishop Creek	Bishop	Calif.	Power	1910	Rock Fill	10	210	75	75	1,450				
Bull Lake		Colo.	Irrigation		Rock Fill	16		108	87					
Calaveras	Calaveras	Calif.	Water Supply	1925	Hyd. & Earth Fill	25	1,200	215	201	1,300	100,000	2,700,000		
Catawba	Catawba	N. C.	Power	1919	Hydraulic Fill	20	643	120	116	1,375		1,910,000		
Cold Springs	Umatilla	Ore.	Irrigation	1909	Hyd. & Earth Fill	20	416	82	80	3,200		620,000		D. C. Henny
Conconully	Snake	Idaho	Irrigation	1910	Earth & Sheet Piling	20	349	99	66	1,030		350,000		
Crane Valley	San Joaquin	Calif.	Power	1923	Rock & Hyd. Fill	15	370	.....	140	1,865		650,000		J. M. Howells
Croton	Croton	Michigan	Power	1907	Earth & Sheet Piling	20	201	.....	55	200		104,000		
Cuyamaca		Calif.	Irrigation	1886	Earth Fill				42	635	11,400		55,000	
Beaver Park	Riverton	Wyo.	Irrigation		Earth Fill				75	3,300	145,000	600,000		
Bog Brook		N. Y.	Water Supply		Earth & Mas. Core	26			60					
Davis Bridge		Vt.	Water Supply	1924	Rock & Earth Fill			200						
Dry Canyon	Dry Creek	Calif.	Water Supply	1912	Rock & Earth Fill	20	298	136	61	528		140,000		J. B. Lippincott
Dix	Dix	Ky.	Power	1925	Rock & Earth Fill	20	1,412	275	275	1,020	300,000	1,747,000		L. F. Harza
Druid Lake	Potomac	Md.	Water Supply	1871	Earth Puddle Core	60	841	119						
Dixville		N. H.			Earth Conc. Core	25			70					
Englewood	Ohio	Ohio	Flood Control	1922	Hydraulic Fill	30	301	124	124	4,700		3,500,000		
East Canyon	E. Canyon Cr.	Utah	Irrigation	1901	Rock—Conc. Core	10	289	129	93	173	8,900		96,000	W. M. Bostaple
Escondido	Escondido Cr.	Calif.	Water Supply	1895	Rock Fill	10	140	76		380	3,000	37,000	110,000	
Encino	Encino Cr.	Calif.	Water Supply	1924	Earth Fill	20	490	127		1,027		502,000		Wm. Mulholland
Fairmont		Calif.	Water Supply	1913	Earth and Concrete	20	612	167	124	1,526		607,000		J. B. Lippincott
Forest Park	Potomac	Md.	Water Supply	1907	Earth Puddle Core	15		87						
Gordon Valley	Vallejo	Calif.	Water Supply	1925	Earth Fill	15		104				310,000		A. Kempkey
Glenwild	Croton	N. Y.	Water Supply	1902	Earth Fill	13	187	92	64	450	3,675			
Germantown	Ohio	Ohio	Flood Control	1921	Hydraulic Fill	25	750	124	110	1,210		798,000		C. H. Paul
Gatun	Pan. Canal	Panama	Flood Control	1904	Hydraulic Fill	110			115					
Grant Lake	Grant Cr.	Calif.	Power	1925	Rock Fill	8	116	37	23	490	10,000			
Goose Creek	Goose	Idaho	Irrigation		Earth Fill	19		145						
Guernsey	Platte	Wyo.	Power	1927	Earth Fill			97		575	72,700	332,000		
Henshaw		Calif.	Water Supply	1924	Earth & Hyd. Fill	20	419	117	.....	650				
Haiwee		Calif.	Water Supply	1912	Earth & Hyd. Fill	20	406	110	82	1,516		599,000		
Huffman		Ohio	Flood Control	1922	Hydraulic Fill	30	269	73	70	3,300				
Horsley	Price	Utah	Irrigation	1926	Earth & Rock Fill						63,000	130,000		
Honey Lake		Calif.	Power		Earth Puddle Core	20			96					
Holyoke	Conn.	Mass.	Water Supply	1885	Hyd. Fill Tim. Core				30	1,017				M. C. Herschell
Hillside		Calif.	Water Supply	1909	Rock Fill	10		88	83	650	14,000			
Indian River	Indian	N. Y.	Water Supply	1898	Earth & Masonry	7	33	67	47	207			92,000	E. A. Fuertes
Ithica	Six Mile Cr.	N. Y.	Water Supply		Brick Masonry				30			121,000	25,000	G. S. Williams
Idaho Creek	Idaho Cr.	Idaho	Irrigation		Earth Fill	40			135					
Jackson Lake		Idaho	Irrigation		Earth Fill				67	4,461	847,000	345,000		
Junction	Junction	Mich.	Water Supply	1918	Hyd. Fill Con. Core	12		61						
Kaukonahua	Kaukonahua	T. H.	Water Supply	1904	Hydraulic Fill	25		98		460		167,000	281,000	
Lockington	Ohio	Ohio	Flood Control	1921	Hydraulic Fill	30	431	78	75	6,400				
Linville		N. C.	Power	1919	Hydraulic Fill	20	805	168	168	1,250		1,213,000		
Lewiston	Snake	Idaho	Irrigation		Earth & Rock Fill	16			85					
L. San Fernando	San Fernando	Calif.	Water Supply	1921	Earth & Rock Fill	20	730	167	142	2,060		2,713,000		J. B. Lippincott
Lower Franklin	Franklin Cr.	Calif.	Water Supply	1916	Earth & Rock Fill	20	500		95	500		274,000		J. B. Lippincott
Lake Frances	Dobbins Cr.	Calif.	Power	1899	Earth & Rock Fill	6	391	77	77	1,300		280,000		

EARTH AND ROCK FILL DAMS—Continued

Name of Dam	River	State	Primary Purpose	Year Completed	Type of Structure	Width At Top Ft.	Width At Base Ft.	Height Feet Above Foundation	Height Feet Above St. Bed	Length of Crest Ft.	Capacity of Reservoir Acre Ft.	Contents of Dam Cu. Yds.	Cost Dollars	Designers of Dam
Lake Francis		Colo.	Power	1902	Earth & Rock Fill	20		70						
Lake Fordyce		Calif.	Power	1927	Rock Fill	10		140		1,030				
Lundy		Calif.	Power	1913	Rock & Conc. Core	30		75	45	670	3,820			
Lake Avalon	Pecos	New Mex	Irrigation	1892	Rock & Conc. Core	43	120	61	53	1,300	5,600		170,000	H. H. McCloud
Lake McMillan	Pecos	New Mex	Irrigation	1893	Rock & Conc. Core	20	141	52	50	1,690	89,000	215,000		L. D. Blauvelt
Lahontan	Truckee	Nev.	Irrigation	1916	Earth Fill	20	157	124	109	1,400	273,000	770,000		
Lake Kachess	Yakima	Wash.	Irrigation	1913	Earth Fill			63		1,400	210,000	193,000		
Laramie	Laramie	Wyo.	Irrigation	1901	Earth Fill	15			35	8,000	120,000	344,000	341,000	Geo. F. Vollmer
Lake of the Woods	.....	Calif.	Irrigation	1926	Earth Fill	14	117	42	30	605				H. Whipple
Lyons	Grand	Mich.	Power	1907	Hydraulic Fill				60	200		104,000		W. G. Fargo
Lake Keechelus	Yakima	Wash.	Irrigation		Earth Fill			70		6,500	152,000	639,000		
La Mesa	San Diego	Calif.	Water Supply	1895	Hydraulic Fill	20	251		66	470		38,000	18,000	J. M. Howells
McMillan	Pecos	New Mex	Irrigation	1907	Earth Fill	27	161	55	51	2,070	45,000	155,000		
Muddy Creek	Sun	Mont.	Irrigation	191-	Earth—Conc. Core	32		92		800	33,000	400,000		
Morris	Naugatuck	Conn.	Irrigation	1925	Earth—Conc. Core	16	140	100	87					
McKay	McKay Cr.	Ore.	Irrigation	1927	Earth Fill				165		73,000	2,330,000	2,350,000	
Meadow Lake			Water Supply	1903	Rock Fill	12	137	74	68	775				
Morena		Calif.	Water Supply	1909	Rock Fill	16	389	260	150	550	47,000	400,000		M. O'Shaughnessy
Minidoka	Snake	Idaho	Irrigation	1904	Hyd. Fill Con. Core	25	300	80	60	650		225,000	550,000	J. H. Quinton
Milner No. 1	Snake	Idaho	Irrigation	1905	Hyd. Fill Tim. Core	20	375	86		340				
Milner No. 2	Snake	Idaho	Irrigation	1905	Hyd. Fill Tim. Core	20	312	81		330				
Milner No. 3	Snake	Idaho	Irrigation	1905	Hyd. Fill Tim. Core	20	342	66		580				
Magic	Snake	Idaho	Irrigation	1909	Hyd. Fill Sht. P. Core	40	782	182	135	625		200,000		
Marshall Lake		Colo.	Irrigation	1908	Hydraulic Fill	24	456	106	72	2,150				
Misselbeck		Calif.	Irrigation	1920	Hydraulic Fill	20	598	117	105	480	5,500	280,000		Thos. H. Means
Merced	Merced	Calif.	Irrigation	1921	Earth Fill	20	290		55	2,200	15,000			
McMillan	Pecos	New Mex	Irrigation	1912	Earth Fill			55		2,070	45,000	152,000		
Minitare	Laramie	Wyo.	Irrigation	1916	Earth Fill	27	364	65		3,700	61,000	570,000		
Number One		Calif.	Power	1908	Rock Fill Tim. Core	10		81	76	1,065	7,750			
Nuuanu	Nuuanu	T. H.	Water Supply	1908	Hyd. Fill Tim. Core	10			77	2,100	2,000			
Ochoco	Ochoco	Ore.	Irrigation	1920	Hydraulic Fill	18	578	127		1,050	47,000	541,000		
Paddy Creek	Paddy Cr.	N. C.	Power	1918	Hydraulic Fill	35	755	165	165	1,472		1,445,000		
Priest		Calif.	Irrigation	1923	Hyd. Fill Con. Core			145		1,000				
Paradise	Chino Cr.	Calif.	Irrigation	1917	Hydraulic Fill									
Piute	Piute	Utah	Irrigation	1914	Hyd. Fill Con. Core				95	1,325		444,000		
Puddingstone No. 1	San Dimas	Calif.	Flood Control	1927	Earth Fill	25			166			714,000	521,000	
Puddingstone No. 2	San Dimas	Calif.	Flood Control	1927	Earth Fill	25		90	75			531,000	497,000	
Pilarcitos		Calif.	Irrigation	1916	Earth Fill	24			95	640	3,622			
Philbrook	Feather	Calif.	Power	1926	Earth Fill	10			90	850	5,000	141,000		
Pechstein		Calif.	Water Supply	1926	Earth Fill	15	316	60	60		320			
Quemahoning		Pa.	Water Supply	1911	Hydraulic Fill	20	710	106	96	950		600,000		Allen Hazen
Ralston	Shoshone	Wyo.	Irrigation	1919	Earth Fill			50		2,200	2,100	24,700		
Rhinedollar		Calif.	Power	1919	Rock Fill	10		48	27	600	322			
Rio Grande	Rio Grande	Colo.	Flood Control	1918	Rock Fill	30	487	100	87	450		203,000		
Relief	Stanislaus	Calif.	Power	1909	Rock Fill	13	100	140		509				
San Pablo	San Pablo Cr.	Calif.	Water Supply	1921	Hydraulic Fill	50	2,030	215	165	1,230	43,000	2,250,000		
Shasta River	Shasta	Calif.	Irrigation	1928	Hydraulic Fill	25	641	105	97	1,250	70,000	700,000		John A. Beemer
Santa Maria	Colo.	Colo.	Irrigation	1913	Hydraulic Fill	20	485	110	93	1,300		310,000		
Somerset		Vt.	Power	1913	Semi Hyd. Fill	25	608	105	105	2,100		1,000,000		
Sanguijuella		New Mex.	Irrigation	1909	Semi Hyd. Fill	20		75						
Stone Canyon	Stone Cr.	Calif.	Water Supply	1924	Hyd. & Earth Fill	20	850	175		567		724,000		Wm. Mulholland
San Leandro	San Leandro	Calif.	Water Supply	1875	Hyd. & Earth Fill	28	1,700	155	125	500	15,000	543,000		A. Chabot
Shaeffer	Shaeffer Cr.	Colo.	Irrigation	1911	Hyd. Fill Rock Core	15	495		96	1,100		390,000		
Silver Lake	Silver Cr.	Calif.	Water Supply	1907	Hyd. Fill Con. Core	20	310	56	54	950	480	146,000		
Strawberry	Stanislaus	Calif.	Irrigation	1916	Rock Fill	15		173	140	612		400,000		
South Lake		Calif.	Power	1911	Rock Fill	10		85		650				

Stevens Type L Water Level Recorder and Volume Meter

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EARTH AND ROCK FILL DAMS—Continued

Name of Dam	River	State	Primary Purpose	Year Completed	Type of Structure	Width At Top Ft.	Width At Base Ft.	Height Feet Above Foundation	Height Feet Above St. Bed	Length of Crest Ft.	Capacity of Reservoir Acre Ft.	Contents of Dam (Cu. Yds.	Cost Dollars	Designers of Dam
Sabrina	Sabrina Cr.	Calif.	Power	1910	Rock Fill	10		75		1,065				
Swift		Mont.	Irrigation	1914	Earth Fill			165						
Standley Lake		Colo.	Irrigation	1912	Earth Fill	20		113						
Spanish Springs		Nev.	Irrigation		Earth Fill			112		2,815	300,000	1,700,000		
San Andreas	San Andreas Cr.	Calif.	Irrigation		Earth Fill	24			93	850	20,000			
Sevier Bridge	Sevier Cr.	Utah	Irrigation		Earth & Steel Core	32		92					38,000	H. C. Kellogg
Sherburne Lake	Milk	Mont.	Irrigation		Earth Fill	22			83	1,135	78,000	201,500		Burr Bassel
South Fork	South	Pa.	Irrigation		Earth & Rock Core	20			72					
Strawberry	Strawberry Cr.	Utah	Irrigation		Earth & Conc. Core			72		4,890	255,000	109,000		
Saddlebag		Calif.	Irrigation	1925	Rock Fill	8	247	47	33	600	12,000			
Tyler	Red	Texas	Water Supply	1894	Hyd. Fill Rock Core			36	32	575	1,170	100,000		
Tabeaud	Jackson	Calif.	Power	1901	Earth Fill	20	620	126		636	1,070	371,000		
Titicus	Croton	N. Y.	Power	1895	Earth Fill Rock Core	30		110						
Tieton	Tieton	Wash.	Irrigation	1925	Earth & Conc. Core	78	1,110	321	233	905	202,000	240,000	4,215,000	U. S. B. R.
Taylorsville	Ohio	Ohio	Flood Control	1921	Hydraulic Fill	30		78	73	3,000				
Terrace	Alamosa	Colo.	Irrigation	1909	Hyd. Fill & Concrete	25	1,050		210	615	25,000	500,000		J. D. Schuyler
Temescal	Temescal	Calif.	Water Supply	1869	Hydraulic Fill	18		115			1,000			
Thompson Creek	Thompson Cr.	Calif.	Flood Control		Earth Fill Rock Core			80	50					
Upper San Leandro	San Leandro	Calif.	Water Supply	1926	Hydraulic Fill	75		200	185	683	51,000	43,000	1,250,000	
Upper San Fernando	San Fernando	Calif.	Water Supply	1920	Hydraulic Fill	20	466		90	4,350		775,000		J. B. Lippincott
Upper Crystal Spgs.	Crystal Cr.	Calif.	Water Supply		Earth Fill			75						
Upper Deer Flat		Idaho	Irrigation					70		4,000	177,000	1,200,000		
Victor	Boise	Colo.	Water Supply	1901	Rock Fill Conc. Core	20	148	70		405				R. M. Jones
Vallejo		Calif.	Water Supply		Rock Fill				52	1,686		215,000		
Waialua		T. H.	Water Supply	1904	Hydraulic Fill	25	580	136	98	460	7,800		210,000	Clay Kellogg
Wichita Falls	Wichita Falls	Tex.	Water Supply	1923	Hydraulic Fill	25		100		7,500				
Yorba	Santa Ana	Calif.	Irrigation	1907	Hydraulic Fill	16	251		47	800	1,170	100,000	38,000	A. C. Kellogg
Castlewood	Cherry Cr.	Colo.	Irrigation	1890	Rock Fill	16		92	70	600	12,800			
Cucharas	Cucharas	Colo.	Irrigation	1910	Rock Fill	28		140	125	600				
Belle Fourche		S. D.	Irrigation	1912	Earth & Tim. Core	19		122		6,200	203,000	1,600,000	900,000	
Croton	Muskegon	Mich.	Power	1907	Hydraulic Fill	21			60	200		104,000		
Cache La Poudre		Colo.	Power	1910	Hydraulic Fill	16		42	38	1,104	5,650		120,000	Gordon Land
Wissota	Wissota	Wis.	Power	1914	Hyd. Fill Con. Core	20	284	82	75					
Wachusetts Dyke		Mass.	Flood Control	1905	Hyd. Fill Tim. Core	189	1,930	82		10,500				
Willow Creek	Sun	Mont.	Irrigation	1925	Hydraulic Fill			73		525	16,700	197,000		
Wanaque		N. J.	Power	1925	Earth Fill Con. Core	16		100						
Zuni		N. Mex.	Irrigation	1907	Hydraulic Fill	20			70	720	6,000	110,000		

For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Page 102

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Horse Mesa Dam and Power House under construction.

$25,000,000 Investment Reclaims Vast Area

(*Continued from Page 36*)

lake and then "portage" the craft around the dam and down to the next lake. Much sport is being anticipated, according to C. C. Cragin, head engineer of the project, by canoeists, who, in regular far-north fashion, will "do" each body of water, carrying their canoes on their backs around each dam.

The completed project will provide electrification of 7000 farms in the district and about 1200 outside. The mines now taking service have installed 80,000 horsepower in steam plants. The Water Users' Association, in control of the project, gets the benefit of the steam standby without investment, which they resell at less than fuel cost. The company at present has a load-factor of 87.6 per cent. This project is in the market center, 80 per cent of the users being within 100 miles of the power plants, the biggest percentage of users being within thirty-one miles.

The original cost of the project reached $125 per horsepower, and the present outstanding debt is $82 per horsepower. During the past six years the capital improvement of the project and payment of public debt, in excess of $1,000,000, was made possible by power income. This was exclusive of any bonded capital improvement, which amounted to $6,600,000. The whole project is being financed by power contracts, which today practically guarantee $1,000,000 per year. According to the engineer's estimate, however, the estimated income for 1927 will be $1,600,000; for 1928, $2,300,000; and in the future $3,000,000 per year. The total investment was $23,000,000 for seven dams, seven power houses, 1300 miles of canals and 153 deep-well pumping plants. The entire project investment is in excess of $25,000,000.

With the business and income thus arranged before construction, it is no wonder then that the people of the district voted favorably 14 to 1 at the first issue and 20 to 1 at the second issue bond election.

The State of Arizona has now 600,000,000 kilowatt hours per year for a population of 350,000, thus making a per capita kilowatt hours of 2000. This compares well with New York State which is said to have 6,000,000,000 kilowatt hours for a population of 10,000,000.

The irrigation districts profiting by the huge increase of water conservation include the Arlington, 5000 acres; Buckeye, 25,000 acres; Roosevelt, 42,000 acres; Beardsley-Agua Fria, 40,000 acres; Litchfield, 10,000 acres; Goodyear (cotton,) 8000 acres; Marinette, 10,500 acres; Paradise Verde, 80,000 acres; Roosevelt district No. 1, 40,000 acres; Salt River Valley Water Users' Association, 240,000 acres, and Queen Creek district, 5000 acres, making a total of former desert lands now productive of 505,500 acres, of which 28,500 acres are in cotton grown by the Southwest Cotton Company at Litchfield, Goodyear and Marinette.

Flood Control Dam

In the deluge of water that is often characteristic of Arizona, there has been an accompanying movement for flood control, the chief project being the Cave Creek dam. This structure was inspired largely by a flood that once threatened the State Capitol Building at Phoenix. The long concrete structure was completed March 4, 1923 and "history" was made when it happened that the last concrete was poured in the giant molds just twelve hours before a peak flood arose. The cost of the control dam was $500,000, made up of contributions. To cap the climax in economy and efficiency, the Water Users' Association is now pumping all drainage waters and distributing the liquid where it will be most useful at nominal cost.

Ultimately the Salt River Valley folk will have no power or irrigation indebtedness, but instead will have a substantial income and profit. A contributing

THE Salt River Valley and areas in vicinity, including the new Coolidge dam and Agua Fria dam, will soon have a chain of lakes and dams and various isolated storage and flood reservoirs, canals, etc., that will generate a total approximately of more than 120,000 horsepower at 90 per cent power factor, and a total storage capacity of water for power and irrigation purposes, of 3,487,700 acre feet (657,431,450 gallons.) These totals represent the capacities and horsepower of the following dams, with other tabulated figures:

Dam and location—	Height (feet)	Width (feet)	Capacity (acre feet)	Horse power
Roosevelt	284	1,125	1,637,000	24,200
Power Canal (future)	.....	.....	14,000	.....
Horse Mest	305	784	245,000	40,300
Mormon Flat	229	619	63,200	10,500
Mormon Flat (to be added)	.....	.....	.....	9,000
Stewart Mountain	180	1,147	70,000	11,500
Southern Consolidated	.....	.....	.....	2,700
Chandler	.....	.....	.....	800
Arizona Falls	.....	.....	.....	1,140
Cross Cut	.....	.....	.....	5,000
Cave Creek (flood control)	.....	.....	14,000	.....
Power Canal (future)	.....	.....	.....	15,000
*Agua Fria (75% complete)	.....	.....	173,500	.....
*Coolidge (beginning)	.....	.....	1,285,000	.....
Totals	.....	.....	3,487,700 (657,431,450 gals.)	120,140

*Agua Fria and Coolidge dams will add many thousand horsepower to above figure.

feature is the fact that, owing to a carefully planned system of roads, no ranch in the valley is more than two miles from a paved road, and all points in the irrigation system are reached by one or more paved roads.

San Gabriel Dam Bids Soon

(Continued from Page 17)

supervisors has agreed to pay the premium on the surety bonds required.

650 Days to Pour Concrete

Specifications state that the minimum amount of concrete to be poured in two 8-hour shifts must be 5000 cubic yards, and if the contractor works at the minimum rate of speed it will require approximately 650 days to place the concrete alone. The board is building a railroad to the dam site. The railroad will be standard gauge track, with 70-pound relay rails. The maximum curve of this road is 24 degrees, and the maximum grade is 2 per cent compensated. The contractor will have full control of the railroad and must furnish the rolling stock and equipment for it. At the completion of the dam it must be turned back to the district in good condition.

Specifications call for a 2-minute mix of all concrete placed in the dam, the amount of mixing water to be controlled by the inundation system. A slump test of 2 to 4 inches will be required. All aggregate, including ten-inch cobbles, must be mixed in the machine. Approximately 6,500,000 tons of aggregate will be required in the construction of the dam, including sand and coarse aggregates. Sand, rock, and gravel may be obtained from the public domain free. This material must pass certain specifications, and the district does not guarantee the supply.

Payments are to be made to the contractor on monthly estimates within the first 10 days of each month, 10 per cent of the amount to be retained up to a total amount which shall not exceed $1,000,000. Final payment is to be made 35 days after completion and acceptance. The total cost has been estimated at approximately $25,000,000.

Contractor's Bid Form

There are 27 items specified in the contractors' bid form with approximate quantities as follows:

River wash excavation below elevation 1360 (Class 1)	475,000 cu. yds.
Open cut excavation (Class 2) rock and other material	875,000 cu. yds.
Spillway tunnel complete	435 lin. ft.
Mass concrete	3,250,000 cu. yds.
Reinforced concrete	10,000 cu. yds.
Precast trash rack screens	250 cu. yds.
Drilling 3-in. grout holes	60,000 lin. ft.
Fitting pressure pipes in grout holes	3,000 holes
Pressure grouting	5,000 cu. yds.
Drilling 3-in. drainage wells	10,000 lin. ft.
Placing split tile drains	2,000 lin. ft.
Copper contract'n seals, placing	11,000 lin. ft.
Forming vertical drains	48,000 lin. ft.
Placing air vent pipe and cut off drain	3,000 lin. ft.
Placing reinforcing steel	1,300,000 lbs.
Placing trash racks	210,000 lbs.
Placing 60-in. steel discharge pipe	1,400,000 lbs.
Placing 30-in. steel discharge pipe	145,000 lbs.
Erecting gates and valves	560,000 lbs.
Placing single pipe rail in galleries	3,420 lin. ft.
Placing double pipe rail	1,700 lin. ft.
Placing ornamental metal rail on face of dam	2,500 lin. ft.
Placing electric conduits	8,000 lin. ft.
Erecting gallery doors	1,000 lbs.
Erecting miscellaneous metal work	5,000 lbs.
Extra forming and finishing surface of waterways	55,000 sq. ft.
Plain stairways	100 cu. yds.

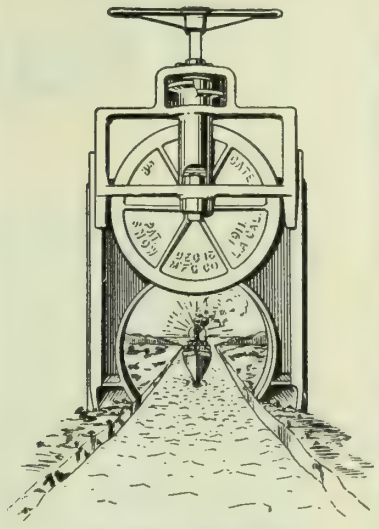
E. C. Eaton is the chief engineer of the flood control district in charge of the work. D. C. Henry, J. B. Lippincott and J. W. Reagan comprise the board of consulting engineers.

A Correction

In the May, 1927, issue of this magazine there appeared an article regarding a new process for lining concrete pipe. Since this was written, we have had an opportunity of studying the concrete pipe field at closer range and find that some erroneous statements were made, which we desire to correct. The article in question should have stated that the Bent Concrete Pipe Co., of Los Angeles, is simply experimenting with the various elements of this process, just as we understand they are, and have been for years, experimenting with many other processes and methods for the development of better production economy of pipe for special uses. At the present, according to the company, they have no idea as to the ultimate value, uses or feasibility of the new process.

It is our purpose, later, to go more fully into the possible uses of this new process if it develops to be of value. A suggestion might be inferred from the above article that there was a need for treating concrete pipe to make it durable in the flow of ordinary domestic sewage. On investigation, we find that many hundreds of miles of plain concrete pipe, manufactured by the high quality standards now prevailing, are performing satisfactorily in sanitary sewer service in leading Southern California cities. Accordingly, it seems possible that this new process, if ultimately successful, may develop a pipe which will pioneer in new uses not now supplied by concrete pipe.

SPECIFY



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Constructing the Main Water Supply Line for the City of Riverside. Reaburn & Bow

WESTERN CONCRI

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For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Page 102

Concrete Pipe

For Pressure Lines

An interior view (unretouched) of the 42″ Main Water Supply Line, City of Riverside. The darker rings indicate the Joints, where the grout was of slightly different mix than the body of the pipe.

Central Bldg., Los Angeles, Engineers in charge of Designing and Construction.

TE PIPE COMPANY

355 CALIFORNIA

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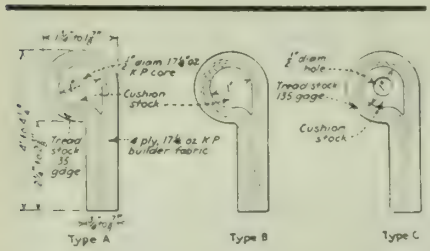
Staunching Device *for* Water Gates



Diamond Rubber Company has produced a new sealing strip now in use on several well known hydraulic projects.

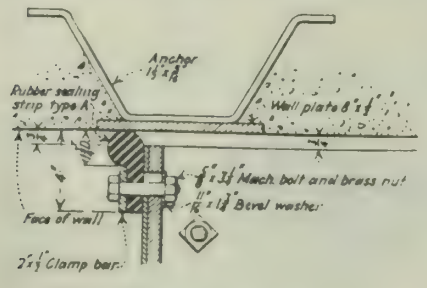
A new type of staunching device has been developed by the Diamond Rubber Company for radial and stoney gates, to replace metal staunching rods, split hose, rubber belting seals, etc.

Three types of this new seal are shown above; and, below. its installation on a radial gate. It is made of rubber and fabric, the inner portion a rubber cushion of great resilience, the outer surface of tire tread stock.

Rubber is ideal for this purpose, as it is one of the least compressible substances, resists wear, and the conditions of dampness and darkness prolong its life.

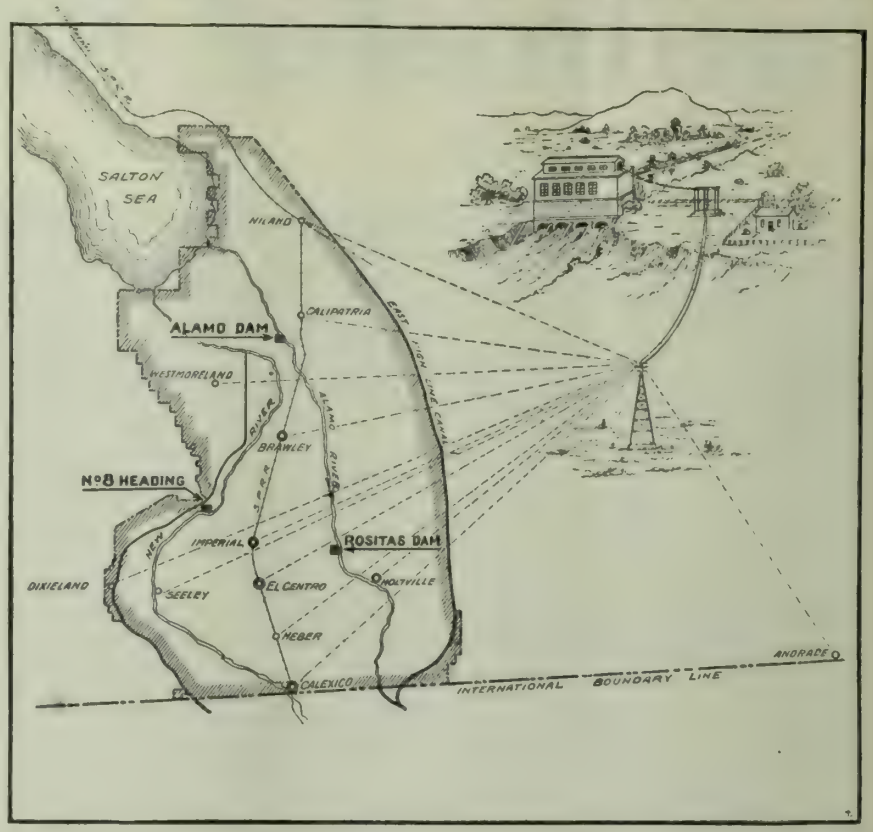
Diamond Staunching Device are now in operation on several well-known projects, and have been thoroughly tested by government engineers.

DIAMOND RUBBER CO.
Akron, Ohio



Diamond Staunching Device installed on a radial water gate.

Estimates 3,150 H.P. Could Be Generated on Imperial District Canals



Water Power Diagram showing locations in the proposed Power System of the Imperial Irrigation District.

IN A RECENT report by M. J. Dowd, engineer for the Imperial Irrigation District, Mr. Dowd stated that there is available approximately 3,150 horsepower that can be generated on the canals of the district. This, it is asserted, would provide cheap power for the irrigators of the district, besides conserving the natural resources. It is estimated that the cost of such a project would not exceed $1,600,000.

In the preliminary report there were three sites selected at which low dams could be built, but it was stated that there are other sites along the canal system at which some power could be developed. It was only the sites at which power could be economically developed that were recommended. These locations are as follows:

Rositas Dam, 45 ft. available head, 1,870 H.P.

Alamo Dam, 13.5 ft. available head, 880 H.P.

No. 8 Heading, 12 ft. available head. 400 H.P.

The accompanying sketch gives the exact location of these sites and their relative position in the district. It is claimed that the power so generated could be supplied at a much cheaper rate than is now being charged, and that the profit could be used in stabilizing the district assessments.

Plans are being rushed to incorporate this plan into the district, and this coming summer will undoubtedly see it materialize.

Installs Pumping Plant

A new pumping plant has been installed on the Lambert tract near El Monte, California, which is said to provide an unlimited supply of pure water for each lot on the tract. A 2000-gallon tank has been put in, and the pumps are operated by a 15 H. P. electric motor, automatically controlled. Fire hydrants have also been installed.

Will Build Crib in River

The application made by the city of Portland, Ore., for authority to construct a timber crib with sand and gravel fill to support a concrete wall in the Willamette River at Portland, has been approved by the Secretary of War, Dwight F. Davis, it has been announced at the Department of War.

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Monighan Excavator Walks in Any Direction

Increased Portability and Economy of Operation Features of This Machine

The increased portability, the larger capacity, and the remarkable economy of the Monighan dragline excavator, equipped with walking device, easily makes it the highest achievement in dragline excavator construction. This machine is more portable than other dry-land excavators of equal size and therefore is adapted to a much wider range of excavation work. With the Monighan such work as digging irrigation and drainage canals and ditches, building levees and railroad embankments, excavating for sewers, large tile drains, and many other purposes, is more readily handled. Its great portability and large capacity also make cleaning ditches and waterways possible, with remarkable economy.

A feature of the Monighan dragline excavator easily appreciated is its ability to walk in any direction. This simplifies the most difficult sort of work and gives the Monighan a great advantage over other types of excavators. The traction device of the Monighan is attached to the upper platform, turns with it, and is carried clear of the ground when the machine is excavating. By merely turning the platform on its turntable, until aligned in the direction it is desired to move, and then setting the traction device in motion, the Monighan will advance straight ahead—by stopping the traction and swinging the machine it can be aligned to advance in any other direction.

This permits the machine to walk back and forth alongside of the work and sidestep across ahead of the excavation, digging wide ditches with a short boom. When walking ahead of the excavation, the machine moves across and alternately excavates from opposite sides of the center line of cut, and so permits the use of a larger bucket on a shorter boom with correspondingly greater excavating capacity.

The Monighan walking dragline excavator will walk over any ground firm enough to carry the weight of a man. This is true because of the very large bearing surfaces used on the side platforms of the traction device and the base of the machine, and because the weight of the machine is so balanced that its weight is equally distributed over the full area of the base.

CONDENSED SPECIFICATIONS OF MONIGHAN DRAGLINE EXCAVATORS

Model	Boom Length	Bucket Capacity	Power	Shipping Weight
1-W	40 ft.	1 cu. yd.	Gas, Diesel or Electric	32 tons
2-W	50 ft.	2 cu. yd.	Diesel or Electric	56 tons
3-W	70 ft.	3 cu. yd.	Diesel or Electric	115 tons
4-W	100 ft.	4 cu. yd.	Diesel or Electric	208 tons

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OVERHEAD IRRIGATION

VICTORIA GETS PHENOMENAL RESULTS FROM "OVERHEAD"

By LIONEL STEVENSON

Superintendent, Dominion Experimental Farm, Sydney, B. C.

THE annual rainfall experienced on Vancouver Island and the Gulf Islands is poorly distributed when considered from the view point of crop production. The average total annual precipitation is twenty-seven inches. This volume of water would be ample for all needs if it came during the summer months, but unfortunately it is confined to that portion of the year, October to April, when soil temperatures are low and there is little or no growth.

During the period of growth the rainfall averages less than an inch per month, with frequent long periods of drought. The district is favored by a slow rate of evaporation, due to the influence of large bodies of salt water, giving comparatively low temperatures and a moisture laden air. This factor of the slow evaporation of soil moisture offsets to a certain extent the great shortage of summer precipitation.

By practising the methods common to good agriculture in dry districts there is always sufficient moisture each season for one crop of any of the standard food plants, providing that each can be developed by July. For general agricultural practice irrigation is not required, but for intensive small fruit, vegetable and orchard work, it is very necessary, if the greatest use is to be made of the land.

Fine Crops With Irrigation

In the city of Victoria and the district of Saanich numerous growers of small fruits, flowers, nursery stock and vegetables use the overhead system of irrigation to aid them in getting the greatest service from their highly capitalized land. Hose lines and sprinklers of various types have been used by gardeners and nurserymen during the summer period, ever since water under pressure has been available. Under natural rainfall one crop has been possible; under irrigation as many as five crops of the quick growing vegetables have been obtained. Second service from the land each season is easily possible even with the longer season vegetables such as potatoes. Frequently the small fruit crop, which by the way is the most important crop of the district, will be cut short through lack of natural rainfall. Many strawberry areas will not develop their plants sufficiently during the first year to give a full crop in the fruiting years, simply for want of water during June, July and August. This condition in the strawberry fields has been responsible for a demand of water under pressure from the strawberry growers. Those fortunate enough to live within reach of the city of Victoria's water supply are making use of irrigation water. The growers beyond the limit of the main water system are waiting for its extension that they, too, may irrigate.

The greatest use to which overhead irrigation has been put in the district is in the production of strawberries, both everbearing and standard season varieties. When the moisture from natural rainfall fails, as it frequently does, the crop ceases. Under artificial rainfall the season, instead of being three weeks long, is extended from June to November, and can be made as full as the water factor can make it.

The numerous small installations of overhead systems in the vicinity of Victoria cover thirty-five acres, the units varying from one-third to four acres in extent. Some phenomenal results have been obtained in yields of the luxury crops, that would not have been possible without the "rain when you want it" system.

Less Water Used

The overhead sprinkler system is used under glass to the extent of nearly an acre in the Victoria district by florists and tomato growers with success. The fine spray from the nozzles set in an iron pipe gives a condition of watering that does not compact the soil, a valued feature in water applications.

The economy secured in the sprinkler system of water application is notable in that it does take much less water and much less human attention than any other system. No ditches to make and attend, no flood losses nor soil puddling, so common with furrow irrigation, to contend with. The water requirement in the Victoria district is only six acre inches per season of irrigation, when applied by the overhead system. Furrow irrigation demands a much large quantity to give the same degree of effective irrigation. The application of overhead irrigation has given the following results in the district about Victoria.

Everbearing strawberries, 9,000 lbs. to the acre.

Blackberries, 600 crates per acre.

Raspberries—Yield under irrigation, 5,997 lbs. to the acre; Yield without irrigation, 2,239 lbs. per acre; Gain in favor of irrigation, 3,758 lbs. per acre.

Note:—The value of this increased crop at 20 cents a pound is $832.60. Cost of handling increase would be approximately $206.00, leaving a balance of over $600.00 per acre to pay for four applications of water. This experiment was made on black gumbo clay—truck system and straw mulch used. The irrigated fruit was high grade. Much of the fruit grown without irrigation was small and second grade.

Potatoes—Yield under irrigation, 10,964 lbs. per acre; Yield without irrigation, 6,187 lbs. per acre; Gain in favor of irrigation, 3,759 lbs. per acre.

Note:—Value of increased product under irrigation at $2.00 per cwt., $75.18. In this instance the potatoes were grown on a gumbo clay. Two applications of water were given at a per acre cost of $15.00. Sprinklers and hose lines were used. The cost of harvesting and marketing the increased product was only $12.00 leaving a high return for the water applied.

Corn, (for ensilage)—Yield under irrigation, 42,700 lbs. per acre green weight; Yield without irrigation, 18,695 lbs. per acre green weight; Gain in favor of irrigation, 23,735 lbs. per acre green weight.

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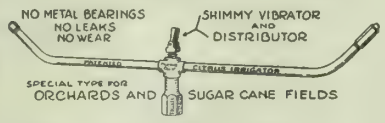

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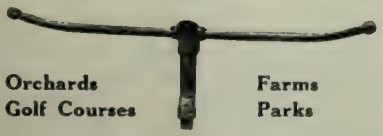

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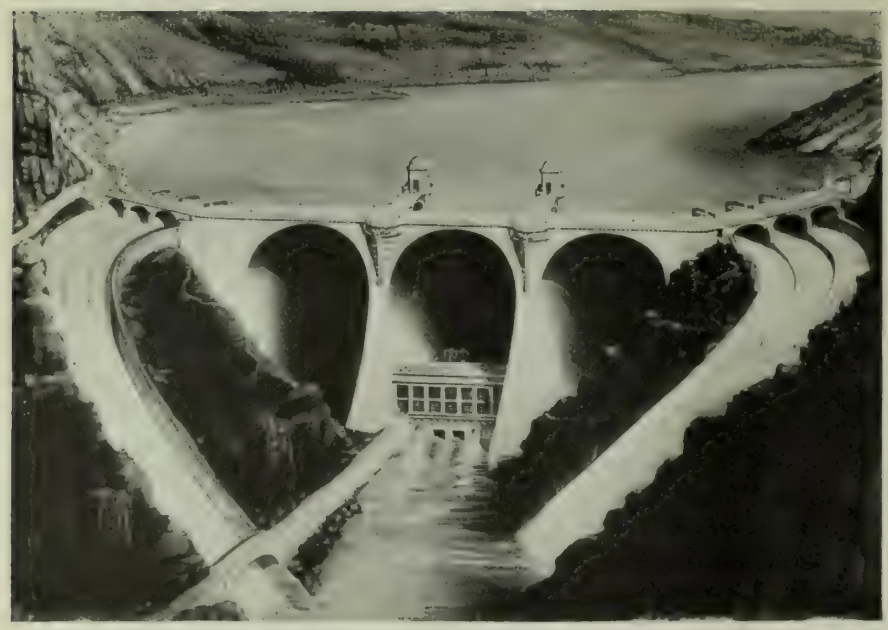

Figure 9. The multiple dome type structure, developed for the Gila River Project (Coolidge Dam) is one of the outstanding types of structures being watched with great interest at the present time.

Types of Storage Dams

(Continued from Page 21)

the United States a score of small arch dams and at least 12 single arch dams of considerable height. Several are under construtions. (Fig. 2 and Fig. 3.) Many more are proposed. The highest of all will be the Pacoima Dam 380 feet high, now under construction for the Los Angeles County Flood Control District. (See Fig. 4 and 5.)

The most interesting arch dam in existence is undoubtedly the experimental arch dam on Stevenson Creek near Fresno, California. In this structure, actual measurements showed stresses of nearly 1,000 lbs. per sq. in., when the reservoir was full. The dam was overtopped in November, 1926, by an unusually large flood to a depth of about 3 feet. The reservoir was filled to a depth of 40 feet at the dam. In spite of this crucial test the dam did not fail, thus giving promise of standing a raising for a considerable additional height before it will break under load.

Multiple Arch Dams

A multiple arch dam consists of a series of arches and supporting buttresses. In this type of dam all the concrete is in compression, except for rib-shortening and temperature effects. A multiple arch dam involves the minimum quantity of material of any of the present known types of concrete or masonry dams. Although the first multiple arch dam, the Meer Allum Dam, was built in India, most multiple arch dams constructed so far are located in the western parts of the United States. This type of dam was developed largely through the efforts of the late John S. Eastwood.

In some multiple arch dams built in the past the question of economy was perhaps given all too much importance with the result that some of these structures have extremely thin cross sections. However, the Selune Multiple arch dam in France, built in 1917, has a thickness of the arches of only 4½ inches at the crest and is 7 inches thick at a depth of 50 feet. It has therefore much thinner arches than any of the dams in the United States.

About twenty multiple arch dams have been built so far in the western states. The highest structures of this type is the Lake Pleasant Dam now under construction on the Agua Fria in Arizona. (See Fig. 6.) This dam is of the double-wall buttress type and will have a maximum height above bedrock of 256 feet. (See Fig. 7.)

Ambursen Dams

Relatively few dams of the Ambursen type have been built in the western states. In the east, however, this type of structure has been used extensively, especially for low heads and on porous foundations. On account of the limitations regarding the span of the deck slabs, and the necessary short spacing of the buttresses, Ambursen dams are often not as economical as multiple arch dams, especially for relatively high structures.

Multiple Dome Dam

The Coolidge Dam (See front cover), now under construction on the Gila River in Arizona, will consist of three domes supported by two intermediate buttresses and the canyon walls. A detailed description of the dome type of dam and of its structural features will be found elsewhere in this issue.

Hoof Type of Dam

This type of structure is in appearance similar to a multiple arch dam with spans of 150 to 200 feet. It is particularly adapted to dams across wide valleys. This type was developed by R. A. Hill of Quinton, Code and Hill.

Round-Head Buttress Dam

In the endeavor to find a type of dam, which would not require the large masses necessary for a gravity dam and without, however, leading to the use of the thin sections of a multiple arch dam, the writer developed a so-called "Round-head Buttress" dam, as shown in Fig. 8. This type of dam is composed of a series of practically independent units, each unit consisting of a buttress wall, and an enlarged buttress head, with rounded up-stream face. Inasmuch as the water pressure is perpendicular to the circular up-stream face of the buttress heads, it is transmitted to the buttress walls by direct radial compression. Consequently, there is no bending moment nor arch action in the buttress heads. Adjoining units are connected by water stops, to prevent leakage. There may also be some expansion joints in the sides of the buttress heads in a direction approximately perpendicular to the up-stream face. These joints, which may be about 50 feet apart vertically, will facilitate the expansion and contraction of the concrete of the buttress heads in a lateral direction.

The round-head buttress dam is essentially a gravity dam and the stresses are calculated in a similar way as for a vertical slice of a gravity type. The up-stream face is on a slope for the purpose of providing a safe sliding factor. The structure is relatively massy, the minimum thickness of wall being 10 feet.

The round-head buttress type enables a saving in quantity of concrete of about 45% over and ordinary gravity dam. The saving in cost may be about 30 to 35%.

Conclusions

The engineer confronted with the problem of designing a dam has evidently the choice of quite a number of different types, all of which may be suitable for the site in question. Comparative designs and estimates of cost will give the only reliable basis for choosing the best feasible and most economical type for construction.

In the preliminary studies for the Coolidge Dam, designs were made for seven different types of dams, and the type that appeared to be the best suited, in this case, the multiple dome, was chosen for construction.

Competitive Designs

A short time ago, the City of San Diego received competitive designs of dams for the Sutherland Site from three different engineers. An expert was appointed by the city for choosing the type best suited for the Sutherland Site. From the nine different designs submitted by the three competitors, the expert selected the multiple arch and Ambursen types, and bids were asked from contractors on both plans. The lowest bid for constructing the Ambursen type was in round figures $1,249,000, and for a multiple arch $897,000. Thus, the chances are that the City of San Diego saved several hundred thousand dollars by this procedure as compared with the process of choosing a type of dam more or less arbitrarily.

In the western states most engineers will prefer a concrete dam to an earth or rock-fill dam if the conditions at the dam site are equally favorable for both types of structures. A concrete structure is susceptible to a fairly rigid analysis as to the stresses in the concrete and the safety of the dam a whole. Earth and rock-fill dams need most skillful and experienced supervision during construction in order to minimize the danger of uneven settlement and leakage. One ever present danger to such structures is the possibility of unprecedented flood conditions, which might lead to overtopping and perhaps to destruction, unless ample spillway capacity and additional free-board for wave action is provided.

West Holds Leadership

The science of dam engineering has made much progress during the past two or three decades. For many years the engineers of the American West have held the undisputed world leadership in the construction of safe and economical types of dams. There is plenty of opportunity for further progress. Construction methods can still be improved. The factor of ignorance in the design of concrete dams may be reduced, thus permitting the saving of a corresponding amount of concrete. The Stevenson Creek Test Dam Investigation of the Engineering Foundation will no doubt furnish a scientific basis for a safe and economical design of concrete dams especially of the arch and multiple arch type.

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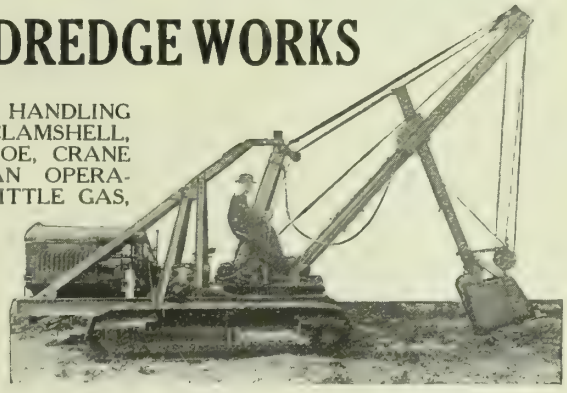

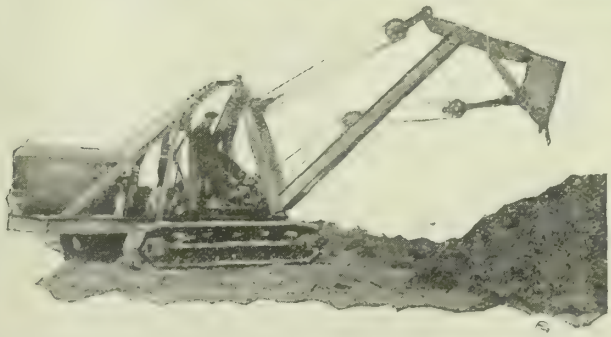

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SURVEY *of* HYDRAULIC DEVELOPMENT

A summary outline of developments contemplated on Western projects which have been announced during the month

Irrigation Development

KENT, WASH.—Plans are being formulated for the organization of the Des Moines Irrigation District. The estimated cost of irrigating 4000 acres is approximately $110,000.

VISALIA, CALIF.—A water conservation district, including the Kaweah River delta region of some 350,00 acres, is to be organized as quickly as the law will permit, which will be July 30th.

SALEM, ORE.—The 18-inch syphon across Bear Creek in southern Oregon, has been approved by the state securities commission. This work is in connection with the Talent Irrigation District. Cost is estimated at $14,000.

PATTERSON, CALIF.—$1,216,376 bond issue of the West Stanislaus Irrigation District carried at recent election. Proposed work will include pumps on the San Joaquin River near the Tuolumne River and the construction of a canal system.

PHOENIX, ARIZ.—The Roosevelt Irrigation District has just made a sale of their bonds and are about to call for bids upon the contemplated development. This district comprises some 37,000 acres in the Salt River Valley section.

HEMET, CALIF.—State approval is expected for the formation of Hemet Irrigation District, which will pave the way for the issuance of $1,000,000 in bonds to finance the many contemplated developments. Plans call for the purchase of the Lake Hemet Water Company, and the irrigation of approximately 10,000 acres on the south side of the valley.

SANTA FE, N. M.—Work is proceeding rapidly upon the survey of the high line canal on the south side of the San Juan River, a step which appears to be the greatest undeveloped irrigation project in the United States, according to State Engineer Herbert W. Yeo, who has recently visited the district. Estimates of the cost of this project are being made at this time.

Pumping Equipment

YAKIMA, WASH.—Word comes from Grandview that the city will sell sufficient warrants to proceed with the installation of a new electric pumping plant.

ARCADIA, CALIF.—City Clerk G. G. Meade has been authorized by city trustees to advertise for bids for the erection of a pump house, reservoir, pumps and motors for the new well south of the city.

MONTEREY PARK, CALIF.—A new high class development is planned for the hills west of Wilson Avenue and south of Garvey Avenue, according to reports recently obtained. The water system which is a necessary part of this development, and it is estimated that the cost of such will approximate $1,500,000. This will include a large reservoir on the hill adjoining the Major Smythe property. Engineer Gierlich has a crew of men now making surveys and laying out the lines for the new system.

Reclamation and Drainage

TUCSON, ARIZ.—The $173,000 bond issue for storm sewer system carried at election May 9. The issue of $120,000 for east and south side interceptor sewers also carried.

EL CENTRO, CALIF.—Permit has been obtained from the War Department for the construction of a brush weir across the Colorado River below Rockdood. This is an annual permit.

KLAMATH FALLS, ORE.—Work is about to start by the government upon the local drainage project. This will include the excavation of the ditch into Langell Valley. Cost is estimated at $60,000.

SAN BERNARDINO, CALIF.—The Board of Supervisors has been requested to appropriate $50,000 for the diversion of San Timoteo Creek flood waters into the Santa Ana River. This work will be undertaken in the very near future.

LAGUNA BEACH, CALIF.—Improvements costing in excess of $250,000 are being advocated by the city planning commission. This money is necessary for the construction of a drainage system and paving some of the city streets.

HOLLYWOOD, CALIF.—The Hollywood Chamber of Commerce is advocating the organization of an assessment district to provide for the proposed storm drains necessary along Oakwood and Laurel Avenues. A general assessment district has been planned for the main drain, and special assessment districts for the lateral. The maximum assessment would be 1 1/3 cents per square foot, and would make the cost to the average property owner $118.

Reservoirs and Dams

ASHLAND, ORE.—Plans for the Canyon Dam are being formulated by interested civic bodies. The construction of this dam is very necessary for the guarantee of the city water supply.

YREKA, CALIF.—Work has been started upon the Shasta River Dam, and other construction work in connection with the activities of the Montague Water Conservation District will soon be under way.

SAN CARLOS, ARIZ.—Bids will be received at the Coolidge Dam, San Carlos, Arizona on July 18th, 1927, for 2500 tons of concrete reinforcing bars. For particulars, address C. L. Shotwell, Special Disbursing Agent, San Carlos, Arizona.

SAN DIEGO, CALIF.—The city is considering another dam site in the Alvarado Canyon near La Mesa. This will be supplied to the city free of cost, and will provide much needed additional storage, acting as a regulator on the present supply system. Estimated cost $300,000.

BURBANK, CALIF.—The city officials authorize the expenditure of $37,500 for the purchase of additional water bearing lands, which are needed for future improvements to the present supply system. A reservoir will be built upon the Sunrise Canyon tract during the coming summer.

BURBANK, CALIF.—Public utilities committee of the city council has announced that two additional reservoirs with a capacity of 6,500,000 gallons each, will be constructed under a proposed improvement program. Several sites have been suggested, and it is believed that two of them can be purchased for $20,000. Councilman Bruce is chairman of the committee.

CHEHALIS, WASH.—The city commission has approved the plans for the construction of the new 5,000,000-gallon reservoir, plans of which were submitted by Engineer Burwell Bantz. The reservoir will be 340 feet in length, 150 feet wide, and 23 feet deep. A 16-foot partition will be built through the center. The cost is estimated at $75,000.

TOKIO, JAPAN—A concern which has been formed by the merger of two Japanese power companies plans to erect a hydroelectric power station at Nozawa-machi in Fukushima Prefecture, according to Trade Commissioner J. H. Ehlers, Tokio. The construction work, which will require four years to complete, will start as soon as the necessary permits are secured. Details are available under reference Japan No. 51126, Department of Commerce.

EVERETT, WASH.—Informal agreement has been reached between the city of Everett, which takes its water from the Sultan River, and Joseph Wickstrom of Gold Bar, head of a proposed $3,000,000 power development on that stream, and work will start as soon as the city withdraws its objections through formal channels. The Wickstrom project consists of a dam, a storage reservoir, and a power plant five miles above the Everett water intake.

TIJUANA, MEXICO—Word has been received from San Diego that construction has been started upon a large dam and reservoir, known as the Garcia dam, located 9½ miles southeast of Tijuana. The cost of this project will be in excess of $3,000,000 and will provide water for the city of Tijuana. Work is being carried on under the direction of Governor Rodriguez. Jesus F. Urias, of Mexicali is the engineer in charge.

EL PASO, TEXAS—Engineer's report, based upon the agreement between representatives of the El Paso Electric Company and the Water User's Association for the construction of the intermittent power project at the Elephant Butte Dam, is ready for signature. The Water Users will be asked to vote the bonds necessary for this construction work which is estimated to run about $2,000,000. Louis C. Hill of Los Angeles is one of the consulting engineers for the association.

NOGALES, MEXICO—A contract has been signed between the National Irrigation Commission of Mexico and the J. G. White Engineering Corporation of New York City for the construction of large irrigation works on the Rio Salado, forty miles northeast of Rodriguez, Tamaulipas. The estimated cost of this project is $3,000,000. R. M. Conner is the engineer in charge of the work at Laredo, and reports that work has already started upon the dam, and the canal. This canal will run from Cameron to San Martin.

PHOENIX, ARIZ.—F. A. Reid, president of the Salt River Valley Water Users Assn., has announced that plans have been prepared for a dam and reservoir across the Salt River at Stewart Mountain, between Mormon Flat and Granite Reed diversion dam, to provide water for both power and irrigation. This will be the fourth in the series of Salt River dams to be constructed by the organization. The new dam will be similar in type and cost to the Horse Mesa project. The proposal will be submitted to the members early this fall.

SEATTLE, WASH.—Constant Angle Arch Dam Co., Hobart Bldg., San Francisco, has been commissioned to prepare plans for a concrete arched dam to be constructed at Diablo Canyon on the Skagit River, to be a unit of the Skagit River power development project. This dam is to provide storage for existing Gorge plant on the Skagit River the intake of which is 4½ miles below the proposed dam, and will be used to supply head for the projected Diablo power house, which will take an ultimate capacity of 180,000 K. W. The proposed dam will be 365 ft. in height, 880 ft. in length at the crest, and will involve 260,000 cu. yds. concrete. Estimated cost is $3,500,000. J. D. Ross, power plant supt., for the City of Seattle, 204 County-City Bldg., Seattle.

LOS ANGELES (SAN GABRIEL DAM), CALIF.—Until 2 p. m., July 11, bids will be received by county supervisors for the construction of the San Gabriel Canyon Dam, carrying roadway and sidewalk, and appurtenant structures, tunnels, spillways, etc., in accordance with plans prepared by the flood control department under the direction of Engineers E. C. Eaton and E. P. McBride. The proposed dam will be an arch gravity type structure, rising 385 ft. above bedrock, 2200 ft. in length on the crest, 360 ft. thick at the base and 30 ft. at the top, providing a storage capacity of 180,000 acre feet. Bids will be taken according to the following schedules:

Proposal No. 1, contractor to furnish all concrete aggregates: (1) 475,000 cu. yds. river wash excav. below el. 1360; (2) 875,000 cu. yds. open cut excav.; (3) 435 ft. spillway tunnel complete; (4) 3,250,000 cu. yds. mass concr.; (5) 10,000 cu. yds. reinf. concr.; (6) 250 cu. yds. precast concr. trash rack screens; (7) 60,000 lin. ft. drilling 3-in. grout holes; (8) 3000 holes, fitting pressure pipes in grout holes; (9) 5000 cu. yds. pressure grouting; (10) 10,000 ft. drilling 3-in. drainage wells; (11) 2000 ft. placing split tile drains; (12) 11,000 ft. copper contraction seals, placing; (13) 48,000 ft. forming vertical drains; (14) 3000 ft. placing air vent pipe and cut-off drain; (15) 1,300,000 lbs. placing reinf. steel; (16) 210,000 lbs. placing steel trash rack; (17) 1,400,000 lbs. placing 60-in. steel discharge pipe; (18) 145,000 lbs. placing 30-in. steel discharge pipes; (19) 560,000 lbs. erecting gates and valves; (20) 3420 ft. placing single pipe rail in galleries; (21) 1700 ft. placing double pipe rail; (22) 2500 ft. placing ornamental metal rail on face of drain; (23) 8000 ft. placing electric conduit; (24) 1000 lbs. erecting gallery doors; (25) 5000 lbs. erecting miscellaneous metal work; (26) 55,000 sq. ft. extra forming and finishing surfaces of waterways; (27) 100 cu. yds. plain stairways.

Proposal No. 2, contractor to furnish 50 per cent and the district 50 per cent of concrete aggregates (district will furnish its material f. o. b. cars in district's yard at Azusa): Items (1) to (3) inclusive, and items (6) to (27) as in proposal No. 1, with the following differences: (4) 1,625,000 cu. yds. mass concrete (made from aggregates furnished by the contractor); (4a) 1,625,000 cu. yds. mass concrete (made from aggregates furnished by the contractor); (5) 5000 cu. yds. reinf. concr. (made from aggregates furnished by the contractor); (5a) 5000 cu. yds. reinf. concr. (made from aggregates furnished by the district). Also contractor to furnish aggregates in items (6) and (27).

Proposal No. 3, district to furnish all concrete aggregates f. o. b. cars in district's yard at Azusa; items, same as in Proposal No. 1.

Plans may be obtained from the chief engineer, E. C. Eaton, 202 N. Broadway, upon payment of $50, returnable.

Sewage Disposal

RIVERSIDE, CALIF.—Election will be held June 21 to vote a $20,000 bond issue for garbage and waste material incinerator.

TUCSON, ARIZ.—The $54,000 bond issue providing for an additional city garbage incinerator unit and for motorizing the collection system carried at election May 9.

SANTA BARBARA, CALIF.—City Engineer C. W. Moore has been instructed to prepare plans for a sewer system in Oak Park Knolls tract.

TUCSON, ARIZ.—The $100,000 sewage disposal plant bond issue carried at election May 9.

LYNWOOD, CALIF.—Resolutions of intention have been adopted for sewer systems in Districts 8, 9 and 10, the work in each to cost approximately $100,000. C. L. Stoddard, city clerk.

JOHANNESBURG, SOUTH AFRICA—Tenders amounting to £151,000 for sewerage extensions may be called for shortly by the Johannesburg Town Council, according to information received from Trade Commissioner Perry J. Stevenson, Johannesburg.

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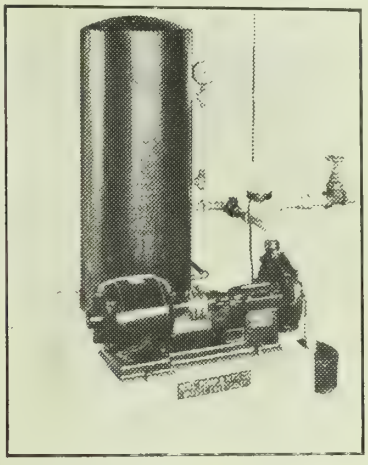

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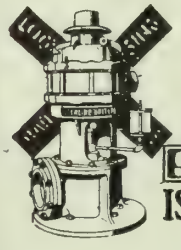

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MONTECITO, CALIF.—Petitions are being circulated in Montecito district for the formation of a sanitary district. If the supervisors grant the petition, a board of trustees will be named and plans and specifications ordered for the work. A special election will have to be called.

BUENA PARK, CALIF.—The $50,000 bond issue of the Buena Park Sanitary Sewer district was sold to a syndicate headed by Russell, Sutherlin & Co., Los Angeles, at a premium of $900. Bids for the work have been authorized. Paul Pratt, La Habra, engineer.

CARPINTERIA, CALIF.—Supervisor Thomas Dinsmore, in whose supervisorial district Carpinteria lies, has announced that a $40,000 sewer system, including septic tank, pumping plant and about 1500 ft. of outfall line into the ocean, is under serious consideration by local property owners. A sanitary district will probably be organized.

BURBANK, CALIF.—A tentative agreement regarding the outfall sewer has been reached between Los Angeles and Burbank. According to the terms, Burbank will receive the right to connect with a metropolitan sewer outfall line which the city of Los Angeles will construct. The engineering departments of the two cities are engaged in smoothing out the various angles of the project and getting it into shape for actual construction. T. R. Mini is city engineer of Burbank.

SAN BERNARDINO, CALIF.—Currie Engineering Co., 209 Stoneman Bldg., Alhambra, has been retained by the city council of San Bernardino to make surveys, and to prepare plans and specifications for proposed new sewer and sewage disposal system. This firm will be paid a fee of 8 per cent of total cost of work, less $3500 the amount of the fee paid to the engineering firm which did the preliminary work for the city. It is probable that the necessary bond issue will be around $500,000. In the event that the bond issue proposal fails, proceedings will be started under the Vrooman act.

Waterworks

STEVENSON, WASH.—A new four and six-inch pipe line will be built in the very near future by the city.

TUCSON, ARIZ.—$250,000 bond issue for water system extensions and improvements carried at election May 9.

WALNUT CREEK, CALIF.—Plans are under way for the enlargement of the present water supply system, and the securing of additional water supplies.

KIRKLAND, WASH.—Work has started upon the pipe line for the new city water system. Work upon the dam has not yet been started.

OAK HARBOR, WASH.—The city is holding a bond election for the voting of bonds for a new city water system. The cost of the system is estimated at $22,000.

RIVERSIDE, CALIF.—Election will be held June 21 to vote a $75,000 bond issue for additional fire apparatus and new buildings for re department.

WINSLOW, ARIZ.—Plans are being considered for the purchase by the city of the water distribution system of the Santa Fe Land & Improvement Company.

BLOOMINGTON, CALIF.—Engineer James E. Sellers of Los Angeles has prepared plans for a domestic water system for the city. The estimated cost of reservoir and distribution system is $50,000.

SANTA MARIA, CALIF.—The city has just voted a bond issue of $65,000 for the purpose of bringing a new water supply into the town.

LONG BEACH, CALIF.—City council has ordered the issuance and sale of $150,000 water bonds. The first work to be done will be a pipe line on Long Beach Blvd.

BAKERSFIELD, CALIF.—The California Water Service Company has appropriated $90,000 to be expended in improvements to the local system, according to a statement of C. B. Jackson.

PLACENTIA, CALIF.—City trustees authorized installation of 12 additional fire hydrants to be placed at various points in the city.

SEATTLE, WASH.—Work is now being started upon the new water system for Lake Forest. The water shed is being cleared and the installation of the tile in the collection system will begin shortly.

ABERDEEN, WASH.—The $1,600,000 bond issue for the Industrial Water System carried at the recent election. Description of this work has been given in detail in the past issues of MODERN IRRIGATION.

HARBOR CITY, CALIF.—A movement is on foot for the establishment of a county water district to furnish this city with water. The present supply comes from the Harbor City Water Company, a private concern.

SHELTON, WASH.—The new water supply system is nearing completion. The distribution system is being installed, and in the very near future meters will be connected up with the service lines.

BALDWIN PARK, CALIF.—The Baldwin Park County Water Board propose a $225,000 bond issue. The money derived from the sale of these bonds will be used in necessary extensions and enlargement of the water plant.

TACOMA, WASH.—An ordinance has been introduced to replace a portion of the Green River gravity system, calling for the reconstruction of nearly two miles of pipe line at a cost of $150,000.

WOODLAND, CALIF.—Articles of incorporation were filed during May by the directors of the Clear Lake Water Company, who will take over the physical assets of the Yolo Water & Power Company.

BELLINGHAM, WASH.—The adjoining community of Ferndale has asked for an extension of the city water system across the county bridge to connect with Ferndale's present system. This was passed by the council.

LONG BEACH, CALIF.—City Manager Chas. S. Henderson has announced that installation of mains for water system replacements in Belmont Shore and Naples Section will start at an early date. Estimated cost of these two systems, about $200,000.

EVERETT, WASH.—The city council has received a proposition from Minck and Oliason, an Oklahoma firm, to purchase the city waterworks. This proposal was made in the form of a cash offer. No action has been taken on the matter.

HOQUIAM, WASH.—The mayor of the city is looking for some consulting engineer to solve the city water problems. It is planned to enlarge the present supply systems, and bring cheap gravity water to the city to be used for industrial purposes.

POMONA, CALIF.—A $60,000 water system will be installed in the Narod District providing the county supervisors approve the plan. Complete specification of the proposed system were laid before the board by the property owners recently, and action will be taken during June.

LONG BEACH, CALIF.—An organization known as the 5134 club has recently been formed by the residents living in the tract of that number. The purpose of the organization is to obtain water for the 150 residents, who are now faced with a serious shortage.

OXNARD, CALIF.—Superintendent T. E. Walker of the water department has voiced a strong recommendation for the installation of meters throughout the city. He states that a saving can be effected by abolishing the flat rate system and using metered service.

BELLINGHAM, WASH.—In order to safeguard the present water supply, the city will extend intake 11,000 feet through the narrows to Strawberry Point (Lake Whatcom). Several new subdivisions are to be supplied with water in conjunction with other plans for water system improvements.

TACOMA, WASH.—Neighboring communities of the southeast Tacoma district have organized a new water company known as the Southeast Tacoma Mutual Water Company, and will spend about $20,000 connecting with the Tacoma Green River supply line.

SEATTLE, WASH.—Work will start in the near future upon the domestic water supply system for the Richmond Beach Water District, according to Mr. Batcheller, engineer in charge. Negotiations for the purchase of the reservoir site, and other preliminary work is now under way.

VANCOUVER, CANADA—Tenders are invited for the supply of 20,000 feet of cast-iron water pipe, Vancouver. Details relative to these and other construction projects in Canada, together with information relative to construction awards, are available to accredited American firms under reference Canada No. 130, Department of Commerce.

REDWOOD CITY, CALIF.—The Pacific Water Company has applied to the Railroad Commission for authority to purchase and operate the distribution system of the Peninsula Water Company, South San Francisco Water Company, and the William H. Howard Estate Company, all in the county of San Mateo. Extensions will be immediately made to the present systems.

BELLINGHAM, WASH.—A general bond election for $250,000 is to be held shortly to extend a new main to and along the water front, erect a standpipe and install a pump to furnish water to the Silver Beach and Larson districts at Lake Whatcom, install master meters on the city mains, a measuring station at Skookum Creek, and to do considerable construction work at Lake Whatcom and Padden Creek intakes.

OLYMPIA, WASH.—Three plans for a new city water system have been submitted by J. L. Stannard, consulting engineer of Tacoma. The Satsop River project, estimated cost of $1,923,600 is being seriously considered because it will provide a gravity system. Other plans have been given consideration, but the pumping costs would offset the initial savings. Bond elections on this project will be held soon.

MONROVIA, CALIF.—June 14th is the date set for the bond election of $235,000 which is necessary for improvements to the present water supply system of this city.

Gibson Dam, Sun River Project

(*Continued from Page 38*)

dam is being constructed in the river section will probably be accomplished through an adit driven into the spillway tunnel above the dam. Temporary openings through the base of the dam at low-water level will be provided to accommodate floods during construction that are too large for the tunnel adit to handle without overtopping the structure. These openings will be closed by filling with concrete and the surfaces of contact thoroughly grouted after the dam is otherwise completed and the tunnel adit plugged.

The outlets for irrigation water will be placed through the central portion of the dam near the downstream water level and will be controlled by two 60-inch balanced needle valves. These valves will be supplemented by high-pressure emergency gates 5 feet square. The openings through the dam from the trash rack structure to the valves will be lined with semisteel conduit lining.

Concrete materials will be secured from deposits along Sun River below the dam site. The mass concrete for the main body of the dam will include cobbles ranging in size from 2½ to 8 inches in diameter. The computed maximum stress in the dam is a little over 600 pounds, and the strength of the mass concrete is expected to show at least 2,000 pounds per square inch at 28 days.

Construction joints radial to the upstream face of the dam will be placed at intervals of 30 feet above and 60 feet below elevation 4650. Each contraction joint will be provided with a drainage well 6 inches in diameter and a copper sealing strip to prevent leakage through the joint. These drainage wells will be connected at the base of the dam to the drainage system described in the next paragraph.

Elaborate Drainage System

An elaborate system of drainage will be installed in the dam to relieve uplift pressure both in the foundation rock under the dam and in the dam itself. This system will consist of 4-inch metal pipes in the upstream cut-off connecting the drainage holes drilled in the foundation to 6-inch horizontal pipes leading to the downstream side of the dam. Connecting to these same 6-inch horizontal pipes 3-inch vertical concrete drains will be located 3 feet from the vertical upstream face of the dam. These drains, as well as the grout pipes, will be located at intervals of 5 feet, the grout pipe being upstream from the drainage pipe. The grout holes will be drilled after the upstream cut-off has been excavated and as soon as the grouting of the foundation has been completed the drainage holes will be drilled into the foundation rock through the 4-inch drainage pipes placed in the cut-off for that purpose. As soon as the drainage holes are drilled the upstream leg of the drainage pipe will be plugged.

Columbia Basin League Meets

The Columbia Basin Irrigation League held a one-day convention in Spokane, Washington, on May 20. The main address of the afternoon session was that of Dr. Elwood Mead, commissioner of reclamation. Following this address, resolutions were adopted calling for the passage of a bill by congress authorizing the basin project and appropriating $250,000 for detailed surveys and explorations as to water storage; approving a $100,000 two-year finance program calling for appointment of a general advisory committee to direct the money raising, and urging Washington, Idaho, Montana and Oregon to hasten the complete allocation of the waters of the Columbia river.

The feature of the evening meeting was the exhibition of a motion picture, filmed by the U. S. Department of the Interior, showing the Columbia basin project from the proposed sources of water supply to the area to be irrigated.

The following trustees were elected:

IDAHO—J. G. Parson, Sandpoint; Lloyd Harris, Lewiston; James F. McCarthy, Wallace; F. F. Johnson, Boise.

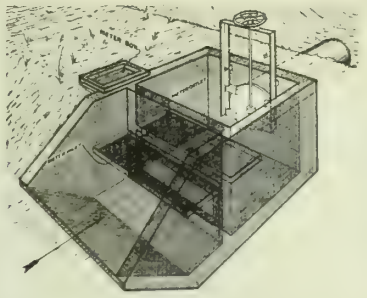
MONTANA—P. N. Bernard, Kalispell; W. J. Jellison, Columbia Falls; E. C. Heidel, Helena.

WASHINGTON — Samuel H. Hedges, Seattle; F. J. MacGougan, Everett; Frank N. McCandless, Tacoma; John W. Langdon, Walla Walla; A. M. Tourtellotte, Newport.

OREGON—U. S. Senator Frederick Steiwer, Pendleton; Marshall N. Dana, Portland.

Littlerock Reservoir Filled

With considerable snow remaining in the mountains back of Littlerock Dam, Los Angeles County, California, the incoming water supplying the dam is keeping it filled while Littlerock pear men are irrigating from it with 750 miners inches and the Palmdale Irrigation District is taking 1000 inches to the large reservoir south of Palmdale. According to Engineer Schoeller, of the Palmdale Irrigation District, the reservoir now has 5500 acre feet of water in it with only 500 acre feet remaining to fill it to its capacity of 6000 acre feet. Water from the mountains will continue to flow for some time, it is estimated, thus making it possible to completely fill the reservoir and leave the Littlerock dam capacity intact. The water in the dam will then be available to Palmdale and Littlerock ranchers.



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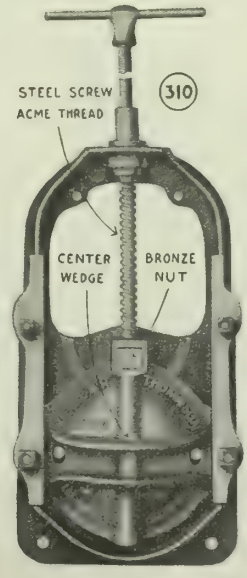

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For General Hydraulic Equipment Listings, See Last Page

Bluewater-Toltec Project

(*Continued from Page 32*)

ers, bins, mixer, etc., and the concrete aggregate for the dam foundation was shot to place from there through some 500 feet of steel chutes. For the top portion of the dam the concrete is shot to a tower and there raised and again shot to place.

Concrete Mix

The concrete mix forming the aggregate for the foundation was per batch as follows: 3 sacks cement; 2.25 cu. ft. rock screenings; 12.75 cu. ft. washed creek sand, and 12.75 cu. ft. of crushed limestone rock, mixed with 28 gallons of water. Rubble rock not in excess of 25 per cent was permitted to be placed in the concrete as it was poured. This aggregate made a very dense and strong concrete and works very well. Later, when the water in the reservoir began to rise, creek sand was cut off and crushed rock sand is now being used. This made a harsh aggregate and would not shoot well, so the mix was changed and the slump increased. The mix as now being used per batch is: 3½ sacks cement; 14 cu. ft. crushed rock sand and 13 cu. ft. of crushed rock limestone, mixed with 34 gallons of water.

Southwestern Portland Cement is used and all cement and concrete samples are being tested by El Paso Testing Laboratories. Concrete aggregate test cylinders are regularly made and tested on 7 and 28 days, one cylinder being kept for future crushing. Some samples, where a question might arise, were taken from the dam and tested.

Weather Problem Solved

Maximum and minimum temperatures were taken during the winter of both the weather and the internal concrete. The minimum weather temperature dropped to 26 degrees below zero on the 24th day of December. During the coldest weather the concrete was protected by canvas and heated with salamanders and steam pipes. Only one pour of concrete was frozen a little around the edges and this was all removed before the next pour.

The structure is of a rather bold design when considering the length of the arch. However, the top is crowned with wide and deep coping that is carefully reinforced to care for any buckling action and all precaution is taken in securing a safe and permanent structure.

The construction of this irrigation project will develop an oasis in the desert, and the 7-mile reservoir lake nestled in the pine-covered mountains will afford a resting place for the tourist and a joyful camping and fishing place locally, that can only be appreciated through actual participation.

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Rubbertex Protects Pipe from Rust and Corrosion

Wrapped Pipe Installed Sixteen Years Ago Found to Be in Perfect Condition

Confirmation of laboratory experiments carried out recently by the Pioneer Paper Company, of Los Angeles, in which isolation of the hydrogen ion, the cause of rust in metal, was believed achieved, has come to light in a communication to the company from the South Montebello Irrigation District, California.

Sixteen years ago the district installed several hundred feet of 18-inch riveted steel pipe, wrapped with Pioneer pipe covering. Recently, about 800 feet of this protected pipe, and a similar amount of unwrapped pipe, were washed out by extremely high water.

Part of the protected pipe was recovered and relaid, having been found by the engineers to be in perfect condition in spite of its long burial in the ground subjected to many types of chemical and electrolytic action. Whereas the wrapped pipe was described as being as good as when first laid, the unprotected metal was so corroded and eroded that much of it was unfit for further use and had to be discarded.

The pipe was supplied to the district by the Lacy Manufacturing Company, of Los Angeles. So impressed were the South Montebello district officials by the condition of the material that when recently they put the entire system under pressure, requiring the laying of another thirteen miles of pipe, the contract was awarded to the Lacy Company with the provision that the pipe be protected by the wrapping and the Pioneer concern's new rust preventer, Rubbertex.

Scientists say that in order for rust to form, iron must go into solution and hydrogen must be given off in the presence of oxygen or certain oxidizing agents. This produces electrolytic action, as every iron ion that appears at a certain spot demands the disappearance of a hydrogen ion at another, with a consequent formation of gaseous hydrogen, which results in rust. Prevention of its formation, therefore, would automatically prevent rust.

It was upon this definite knowledge that the chemists of the Pioneer Company worked in perfecting Rubbertex. In the past the trouble has been to find a material which could be compounded for the treatment of iron so that it would stand up under all soil conditions and the widest extremes of temperature variation. Tests have shown that the Pioneer concern's product does this, and the savings which will be effected when it is brought more widely into use will, the company says, run into millions.

Proposed Santa Ana Canyon $5,000,000 Project

(Continued from Page 41)

however, that the dam is not intended to create a storage reservoir. It is to be a check dam, the object of the project being to control the flow of water, not to stop it.

For Water Conservation

The lower 81,500 feet of this reservoir would be for the conservation of water and valves therefrom would be subject to control. The remaining upper 92,500 acre feet would be for flood regulation and the openings therefrom would be without gates and large spillway is planned at the flow-line of the reservoir. With such a reservoir it would be possible to deliver a regulated supply of 120,000 acre feet, according to Lippincott, in both ordinary and wet years.

It is proposed to acquire 1000 acres of river channel lands below the dam on which to spread flood waters and facilitate their seepage underground. It is estimated that with such an arrangement 99 per cent of the surplus water that has ordinarily gone into the sea during the past twenty-nine years of observation could have been put underground.

The plan to operate the reservoir would be as follows: The dam would be constructed with gates at the bottom to release the 120,000 acre feet of gravity supply, obtained from the overseason storage, as required. This overseason storage can be obtained with a maximum water level altitude of 510 feet. At that elevation a syphon spillway having a capacity of 1000 second feet would be provided, to release the flood waters as they accumulate in the reservoir, above the regular overseason storage. As the flood waters continue to accumulate, this syphon would continue to discharge 1000 second feet until the water had risen to a 515-foot altitude, at which point another syphon would be located with a capacity of 1000 second feet, making the discharge 2000 second feet when the water had reached that level. Five feet higher, at 520 feet altitude, would be a third syphon, also carrying a discharge of 1000 second feet, bringing the flow at this level to 3000 second feet. If the flood water rose five feet higher it would be going over the overflow spillway, with a capacity for exceptional floods.

All Water Would Be Used

By this means the regular flow of water could be used as desired, any excess during flood periods would be let through gradually and thus be given an opportunity to sink into the ground in the spreading area below the dam, instead of rushing down unchecked, to devastate the valley and waste itself in the ocean. Through the operation of this combination check dam and reservoir, it is declared that no water, excepting in extreme flood time, would flow below the Chapman Street bridge west of the city of Orange.

The construction of this dam, just above the railroad crossing at Prado (or Rincon), would necessitate rebuilding a section of the Santa Fe Railroad, approximately five miles long, to avoid the reservoir basin, through a corner of which the railroad now runs. It also would be necessary to divert the highway for a short distance.

One of the principal benefits which should result from the use of the proposed check dam, it was explained, is that there would not only be more water available, but that the water coming down the Santa Ana River would be available at the most ideal period for irrigation.

More Efficiency

It is declared to be a fact that 40 per cent of the irrigation water now being taken from the Santa Ana River in canals is taken outside of the ideal irrigation period. It is now taken whenever it is available. If, through the use of the proposed dam, a supply were available at all times, it is reasonable to conclude, it was said, that irrigation could be made far more efficient and more beneficial to crops by taking out the water at exactly the right time.

"The present diversions from the lower Santa Ana River for irrigation purposes," Lippincott declared, "are about 40,000 acre feet per annum, of which 16,000 acre feet are taken during the season when the water does not produce the greatest benefit to crops. With 81,500 acre feet of conservation water at Prado, 120,000 acre feet annually could be delivered during the period of ideal use. Twenty-four thousand acre feet is now so diverted. The beneficial regulation, due to the reservoir, would be, therefore, 96,000 acre feet of gravity water annually. An average of about 20,000 acre feet annually would be prevented from going into the ocean."

The cost of building the Prado dam, according to Lippincott, including the spreading works and the highway and railroad expenses, will be tentatively $5,000,000. The gross annual benefits resulting from the building of this reservoir are put at $835,000, and the annual cost of interest nad maintenance $300,000. Therefore, the estimated annual net benefit is $535,000.

"The Prado dam site is situated at a point where it could be effectively utilized as one of the distributing units for the waters diverted from the Colorado River, in case such an aqueduct as has been proposed is built," Lippincott said.

In case the Prado dam project, as outlined by Lippincott and unofficially approved by the state engineer's office, receives a favorable vote from the people of Orange County, the project will be financed by forty-year bonds bearing 5 per cent interest, retired in forty equal annual payments.

Stormy Gorge Dam Example of Ambursen Type Structure

(Continued from Page 46)

The outlets for irrigation water are located on the north side of the creek and are controlled by one 10-inch and two 42-inch balanced needle valves. The 42-inch valves are supplemented by high pressure emergency gates 3 feet 6 inches square, the emergency gates and balanced valves being connected by 50-inch riveted steel pipe. The gates, pipes, and valves are located between buttresses. The 10-inch needle valve is located between buttresses No. 35 and 36, receives its water supply through the same trash rack as the 42-inch valves, and discharges into an 18-inch pipe leading to the south side of the river at the intake of the Angle-Troxel Ditch, for which service this valve is provided.

The truck haul on all materials shipped in is approximately 8 miles, Fruto being the terminus of the Southern Pacific branch from Willows on the main line.

It will require approximately 1,500,000 pounds of reinforcing steel for the concrete reinforcement. The buttresses are reinforced with rail steel, while the face slab and corbels are reinforced with billet steel. The majority of the reinforcement bars are cut to lengths and the bending done at the mill.

Laboratory Control

Concrete materials to be used for the dam have been tested in the laboratory of the Bureau of Standards at Denver and at the field laboratory established at the dam site, which is equipped to test the field specimens of concrete as the work progresses. Cobble rock 6 inches or less in diameter will be used in the concrete for cut-off trenches, buttress footings, and buttresses below elevation 774.0. In the buttresses above this elevation the maximum size of the coarse aggregate is limited to 3 inches diameter and in the face slab which is heavily reinforced the maximum size of coarse aggregate is limited to 1¾ inches in diameter. Sand will be measured by the inundation method, and gravel will be measured by means of batchers equipped with strike-off devices.

Power for lighting the dam and operating the spillway and high pressure emergency gates will be developed through batteries and a trickle charger from a small generator connected to a 15-inch pelton water wheel. A gas engine will be provided for use when the reservoir is too low to operate the pelton wheel.

It is proposed to drill grout holes about 5 feet apart in the upstream cut-off after the excavation has been completed, and this area will then be grouted to render it impervious to water under reservoir head. It is expected that considerable grouting will be necessary in the area surrounding the line of fault in order to cut off possible seepage from the reservoir floor.

Excavation for the buttress footings and upstream cut-off was started about the 1st of January, 1927.

Two Malheur Districts Merge

Consolidation of the Jordan Valley and North Side reclamation districts in Malheur County, Oregon, it is believed, will put this project on a sound financial basis. Bonded indebtedness of the Jordan Valley district was $400,000 and that of the North Side $30,000. With other considerations, plans were worked out by directors of the two districts, with the cooperation of State Engineer Lewis A. Stanley, for a consolidation which will result beneficially to both.

The bonded indebtedness per acre in the Jordan Valley district will be decreased by addition of the North Side lands, and the somewhat questionable water right of the North Side lands will be made secure. North Side works have been deeded to the Jordan Valley district, and the $30,000 bonds are to be canceled. The Jordan Valley bonds have been sold to pay all indebtedness of North Side. With this merger the settlers of the two districts feel that this rich farming section is now entering upon an era of success.

Reclamation Congress Date Set

The Oregon Reclamation Congress will hold its annual convention for 1927 at Prineville October 13, 14 and 15, according to an announcement made by the trustees of the congress at a recent meeting in Portland. Program arrangements will be in the hands of W. L. Powers, soil specialist of Oregon Agricultural college, secretary of the congress. Dr. Elwood Mead, commissioner of the bureau of reclamation, has been invited to speak before the congress on a national land settlement policy for reclamation projects.

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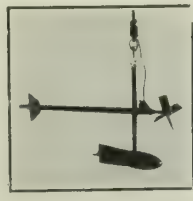

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WHO'S *WHO* AND WHO'S *WHERE*

IN THE WORLD OF HYDRAULICS

Personal Notes and Impersonal Observations About Men You Know

G. H. Hogue, assistant engineer on the Boise project, has been transferred to the Minidoka project.

John K. Rohrer, junior engineer on the North Platte project, has been transferred to the Minidoka project, Idaho.

Charles S. Hoag, junior engineer on the Grand Valley project, Colorado, has been transferred to the Gooding project, Idaho.

E. W. Kronquist, irrigation engineer of the Bureau of Indian Affairs, visited the Newlands project, Nevada, recently to look over the drainage work in progress.

H. W. Lawler, general superintendent of construction for the Utah Construction Company, spent several days recently at Gibson Dam, Sun River project, Montana.

J. L. Lytel, superintendent of the Yakima project, Washington, visited the Stony Gorge dam of the Orland project, California, on his way home from the Yuma conference.

Harold F. Gray, who has been engaged in sanitary and hydraulic engineering since 1907, and who is the author of a number of books on various phases of sanitary engineering, has located in Berkeley as consulting engineer.

Daniel R. McFarland has been appointed resident engineer on the San Gabriel dam which is being built as part of the Los Angeles County flood control work. Mr. McFarland was resident engineer on the Exchequer dam, Merced Irrigation district, California.

Dr. Elwood Mead, commissioner of reclamation, has returned to the Washington office after an absence of two months and a half during which he attended the Pan Pacific Conference in Hawaii and visited a number of the irrigation projects of the bureau.

George C. Kreutzer, director of reclamation economics, was on the Belle Fourche project, South Dakota, recently to confer with the district board and local organizations on matters pertaining to industrial development and settlement of the project.

R. C. Rutter, who was resident engineer on construction of Lake Pleasant dam, Maricopa County Municipal Water Conservation District No. 1, Phoenix, Arizona, has gone into highway work in Harris County, Texas, and is now located at Houston, Texas.

Col. William J. Barden, Corps of Engineers, who has been division engineer of the North Pacific Division and district engineer at Seattle, has been transferred to New York City, to be division engineer of the Northeast Division and district engineer of the Third New York District.

A board of engineers composed of Consulting Engineer A. J. Wiley, Engineer Byrum W. Steele, Construction Engineer H. J. Gault, and Project Superintendent R. C. E. Weber, met recently on the Orland project to report on various construction details of the Stony Gorge dam.

F. O. Osborn, chief appraiser for the Denver Joint Stock Land Bank, spent several days on the Uncompahgre project, Colorado, obtaining information with a view to making loans on the project under the amortization plan after the execution of the proposed contract providing for adjustments on the project.

F. M. Atkinson, assistant state engineer of New Mexico, is organizing the work preparatory to a hydrographic survey of the Vermejo river from its headwaters to the vicinity of French, New Mexico. The purpose of the survey is to arrive at the "duty" or usage of the waters of the stream, to enable the district court to settle the rights of the various claimants to the use of the water.

Fred Y. Nelson, who is a graduate of the University of California in sanitary engineering, and who was formerly employed by Chester H. Loveland, Inc., consulting engineers in San Francisco, has been appointed to the Jacob E. Decker & Sons fellowship at Iowa State College for the study of packing house wastes.

C. M. Day, mechanical engineer from the Denver office of the bureau of reclamation was on the Boise project recently, looking over Arrowrock valves and conducting tests of the Rock Canyon pumps. He also visited the Minidoka project and inspected the work being done on the installation of the sixth unit at the power house.

Clyde C. Kennedy, who has been engaged in private practice in San Francisco as a civil engineer specializing in municipal engineering in all its branches, has been appointed city engineer of Lemoore, California. Mr. Kennedy's first problem is to revise the sanitary sewer system of the city and to design a treatment plant for handling trade wastes.

John Lyle Harrington, construction engineer of Kansas City, Mo., and senior partner in the firm of Harrington, Howard and Ash, has been appointed a member of the board of trustees of Robert College, Constantinople. Mr. Harrington takes special interest in the engineering school of Robert College, where the government is training twenty-five students who will later work for the installation of sewage, water, and electric light systems in the interior of Turkey.

H. A. Van Norman, assistant chief engineer of the Los Angeles Bureau of Water Works and Supply, has been spending several weeks in the hospital as a result of injuries received when his automobile overturned as he was on his way back from an inspection trip to the scene of the dynamiting of the aqueduct in the Owens Valley. Mr. Van Norman's jaw was broken and his left arm just below the shoulder. Three others in the car were also injured, one of them suffering a broken back.

MODERN Irrigation

The Magazine of Applied Hydraulics

CALIFORNIA STATE

Vol. III JULY, 1927 No. 7

DON PEDRO DAM, RESERVOIR AND POWER HOUSE

In This Issue—

Economic Problems Involved in Farming Under Irrigation

The Don Pedro Dam—How It Was Built and What It Cost

Bids for the Construction of San Gabriel Canyon Dam

Annual Report of the East Bay Municipal Utility District

—and Articles of Especial Interest to the Waterworks Industry

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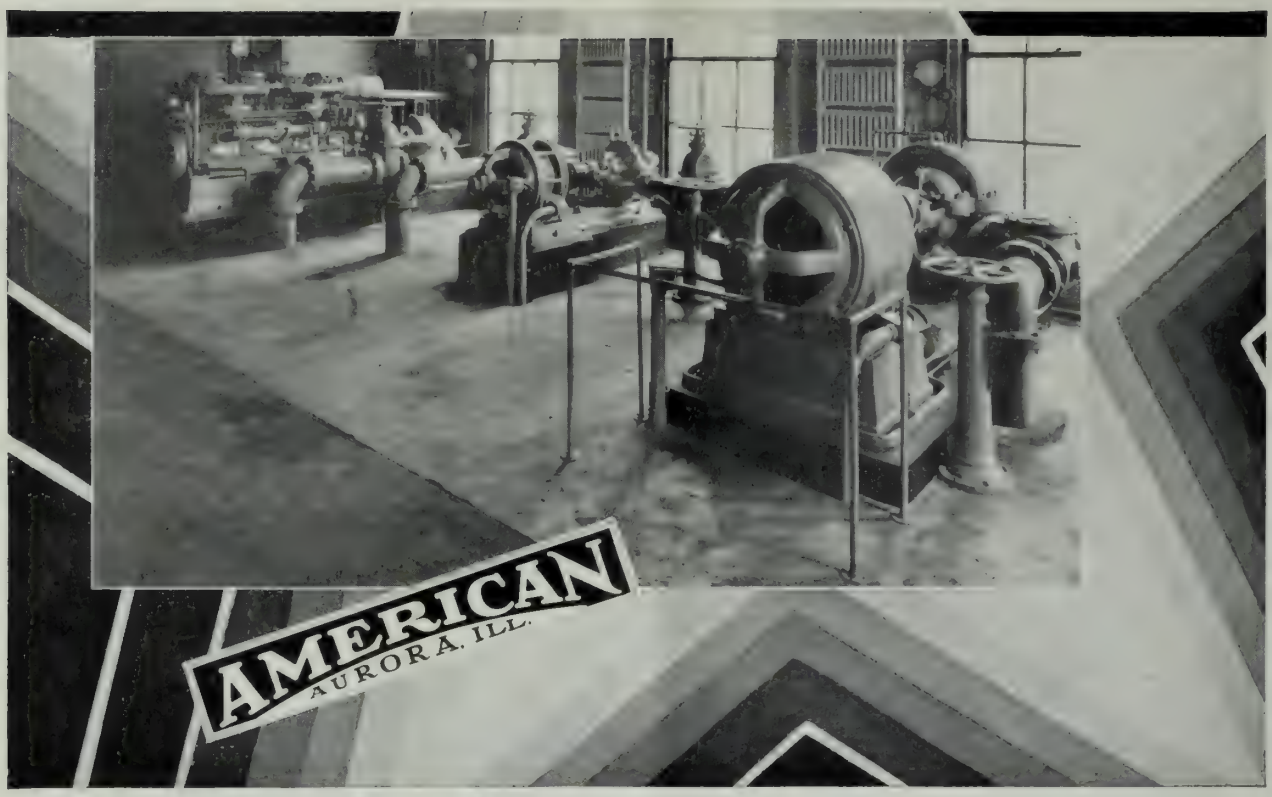

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All these motors are provided with Sundh automatic starters. This installation was made in 1924 and replaced the old steam-driven station that had been in service for a considerable length of time. City engineers should be interested in the economies effected. "American" engineers will be glad to furnish details.

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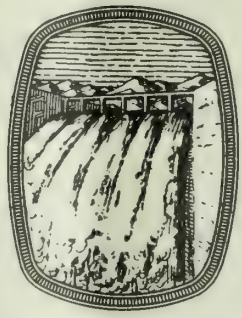
"Western Waterworks" Begins on Page 25 ☛

ANDREW J. WILEY

Widely known consulting engineer, who has been identified with many western irrigation projects. Mr. Wiley is a graduate of Delaware College, and began the practice of his profession in 1882. He is responsible for the design of many hydraulic dams along the western slope and in Idaho. His work as consulting engineer for the United States Bureau of Reclamation, in which capacity he served for twenty years, has made him one of the most experienced men in his field.

MODERN Irrigation

The Magazine of Applied Hydraulics



Volume III JULY, 1927 Number 7

The Progress *of* Irrigation

THE REPORTS of progress on irrigation projects are changing to reports of completion. The past few weeks have been marked by the dedication of many important projects in various sections of the West.

An event of peculiar interest to the engineering world was the dedication on June 26, of Lake McClure, Merced Irrigation District, California, by the American Society of Civil Engineers to the memory of Wilbur Fiske McClure, "in appreciation of his lovable character and in recognition of his engineering service in the advancement of irrigation in California." The dedicatory address was made by Albert Givan, of the Sacramento Section of the American Society of Civil Engineers. Among the other speakers were D. K. Barnell, president of the Merced irrigation district; Walter L. Huber, representing the San Francisco Section of the A.S.C.E.; Harry Hawgood, Los Angeles Section, and Paul Bailey, State Department of Public Works.

During Mr. McClure's fourteen years of service as state engineer there was a great expansion in the activities of the office. State supervision of irrigation and reclamation development and dam construction originated and grew to large proportions during this period. Engineering investigational work became an important function of the office. From the time Mr. McClure took office, in 1912, until his death in 1926, over $120,000,000 of state-approved bonds were issued for construction work through the organization of 100 irrigation districts. The total area included in these districts is three and a half million acres, three fifths of all the land under irrigation in California. The naming of the great lake back of the Exchequer Dam is a fitting tribute to the life and work of Wilbur F. McClure. One might wish that more structures commemorated the names of the engineers instrumental in their being.

On June 30 the consummation of two years of intensive construction work was realized when Secretary of Commerce Herbert Hoover signaled from Washington the release of water from the huge Bowman reservoir of the Nevada Irrigation District, Nevada County, California. The opening of the gates of the Bowman Dam marked the completion of the first and most important unit of the District's initial water development and heralded the beginning of a new era of agricultural progress in the foothills of Nevada and Placer counties. For the first time abundant water from the mountains was

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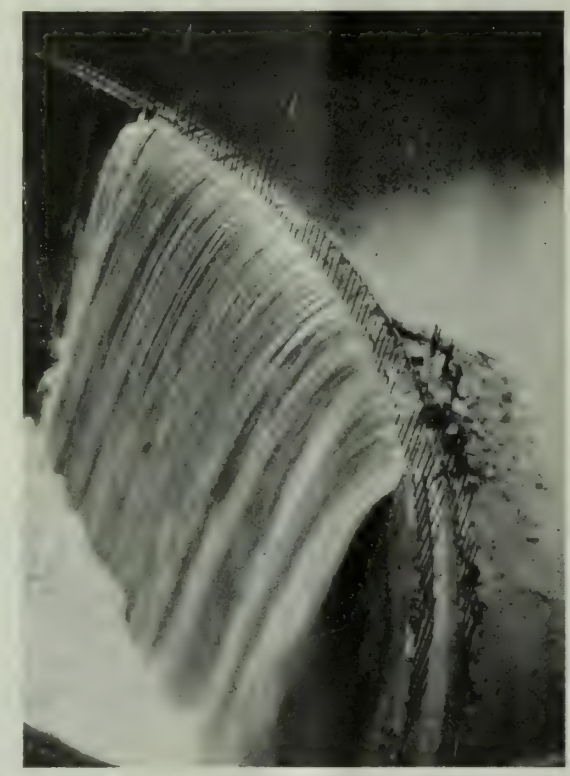
brought to the land under the complete direction and control of the land owners.

The Nevada irrigation district project falls naturally into two distinct units. The Mountain Division includes the water production system, while the District Division forms the distribution system. The work of the Mountain Division under the initial construction program will cost approximately $4,000,000. It includes the largest rockfill dam in California and probably the second largest in the world. It includes two large concrete arch dams, one at Bowman Lake and one in the Middle Yuba River, and two smaller concrete diversion dams, one on Canyon Creek and one on Fall Creek. It includes six tunnels, one of them over four miles in length, probably one of the longest tunnels ever built for the exclusive purpose of water diversion. It includes two miles of metal flume nine and one-half feet wide, 5075 feet of pipe line, 7 feet in diameter, and six miles of open canal.



An interesting example of the thin arch type of dam structure—The Morris Dam, Willits, California.

The new rockfill dam at Bowman Lake stands on the site of the old Bowman dam, designed and built by Hamilton Smith, Jr., more than fifty years ago to store water for the hydraulic mines on San Juan Ridge. The new structure is a massive rockfill, built of cleanly washed granite from the old dam and from near-by quarries. The upstream portion, 25 feet wide at the bottom and 6 feet wide at the top, is built of large rocks, forming a rubble masonry wall which enables the front slope to be made steeper than the loose rock pile on the rear. The crest of the dam is 15 feet wide, 715 feet long, and 167 feet in height above the bed of the stream. The dam contains 316,000 cubic yards of rock, and 8475 square yards of concrete facing. The reservoir covers an area of about 825 acres. Water is released through a tunnel which passes through the solid rock under the south abutment and is controlled by valves at the outlet end. The total cost of the completed dam is about $849,000.

The Melones dam, joint property of the South San Joaquin and Oakdale Irrigation Districts, and the Melones power house, built by the Pacific Gas and Electric Company, were formally put in service on June 11. The expenditure of $4,700,000 for this project represents a novel agreement between the irrigation districts and the power company. The project embodies practically all the ideas advocated by Secretary of Commerce Hoover, who has challenged the West to make double use of its water resources. Each district bonded itself in the amount of $1,100,000 for the construction of the dam, and the power company constructed a plant, capable of generating 36,000 horsepower, at a cost of $2,500,000. In exchange for the use of water passing through the dam, the power company will pay the districts the sum of $5,175,000 over a period of 40 years, thus paying off the entire bonded indebtedness of the districts, plus the interest.

The development is located on the Stanislaus river about twelve miles below the famous mining town of Melones and eight miles west of Jamestown, or "Jimtown" of the days of '49. The reservoir will have a capacity of 112,500 acre feet of water. The dam is 185 feet high and is said to be the second largest overflow type dam in the United States. The length across the crest is 290 feet. When the water is released it passes through a horse shoe shaped concrete lined tunnel 14 feet in diameter and approximately one mile in length to the power house, where it is separated into two pipe lines, each extending to an 18,000 horsepower electric generator in the new plant. After passing through the power plant, the water continues to flow down the Stanislaus

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Securing Closer Relationship Between Farm Development and Irrigation Construction

An Outline of the Economic Problems Involved in the Development of Agriculture Under Irrigation in the West

By DAVID WEEKS and CHARLES H. WEST

In Cooperation with the Federal Land Bank of Berkeley

THE State of California comprises 100,000,000 acres; 29 per cent is agricultural land, 12 per cent is cultivated, and 15 per cent may ultimately be irrigated. Seven per cent is under irrigation projects completed or partly constructed. Six per cent is irigable, and 5 per cent is irrigated. The inexpensive irrigation projects are completed, and future construction will be for large projects or for small but very expensive ones. These will obtain water by constructing storage reservoirs or by the use of pumping machinery to raise the water to high elevations.

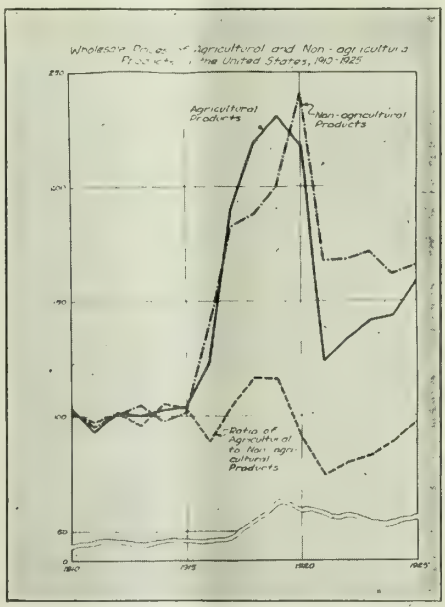
From 1850 to 1890 irrigation projects were constructed by financial promoters or by groups of land owners, who incorporated water companies. Since 1890, there has been an increasing tendency for irrigation construction to be carried on through the organization of irrigation and reclamation districts. In the past ten years, practically all of the project development has been through these types of organizations.

Today we are contemplating the combination of many irrigation districts into large state storage districts to develop and control all of the run-off of certain of our large streams. From 1909 to 1920 there was an increase of 58 per cent in the irrigated area of the state, but irrigation construction was provided for a slightly larger area.

Situation in 1924

Lag Between Irrigation Construction and Profitable Farming: Since 1920, the rate of construction has decreased and so has the settlement of land, but not so fast. It is estimated that in 1924 there were 1,200,000 acres of undeveloped land provided with irrigation equipment that were not using the water. Of the irrigated area, it was estimated three-fourths of a million acres were only partly prepared for irrigation. Only two-thirds of the irrigable area was making full use of the water and 20 per cent was making no use whatever of the construction installed. The increase in irrigated area from 1919 to 1924 was estimated at 500,000 acres.

If future settlement of irrigated land takes place at the same rate as during the past five years, it will take from 15 to 20 years to develop all of the land for which construction has already been provided. Recently organized irrigation districts have large annual district assessments. Fifteen years of these taxes total a large sum. This lag between the date of construction and the full utilization of the water is a maladjustment that may be accounted for in many ways.



Wholesale prices of agricultural and non-agricultural products in the United States, 1910-1925

Possible Causes of Maladjustments: Although it may be impossible so to adjust the relationship between irrigation and agricultural development that there is no delay in development, a thorough knowledge of the causes of the lag in development behind construction, should furnish the basis of improvement. The principal causes for the absence of synchronism between agricultural development and irrigation construction have been analyzed. Business conditions, factors urging irrigation construction and factors affecting rate of agricultural development all have an important bearing upon this problem. The degree to which all of these elements are taken into consideration by officials, engineers and promoters in determining feasibility of projects has a great deal to do with the rate at which projects are developed once they are created.

The Relation of Business Conditions to Construction and Settlement: Irrigation construction is influenced by conditions of the financial market. Rates of construction correspond almost exactly with interest rates of the previous year. There is a direct relationship between the rate at which irrigation projects are organized in California and interest rates on 60 to 90-day paper in New York City. Land settlement, on the contrary, is stimulated by depressed industrial conditions, reflected in low prices of all commodities. Inasmuch as there is a tendency for high prices and high interest rates to accompany one another, the peak of high prices usually having just passed when interest rates are at their high point, irrigation construction tends to accompany periods of high prices of all commodities.

Large profits stimulate irrigation construction. In periods of high prices many more projects are undertaken than in times of depression. Land settlement tends to accompany low prices of all commodities. Different causes, therefore, seem to be at work stimulating land settlement and irrigation construction. This may not be true over long periods of time, but it is shown by statistical analysis to hold over several years, notwithstanding the fact that in the long run the demand for agricultural commodities is the common cause both for irrigation construction and agricultural development. These different causes which are usually opposite give rise to the possibility of maladjustment due to this factor alone, but there are other causes which throw irrigation construction and agricultural development out of adjustment with each other.

Factors Urging Irrigation Construction: Political influence, booster organizations, farmers desiring to shift from dry farming, which has become unprofitable, and speculation in land are all urging irrigation expansion.

Rising Costs

Factors Affecting Rate of Land Settlement: Irrigation construction costs in general, will be larger with each succeeding project. They reduce the margin of possible net profit from land development and will make more difficult the repayment of development costs. This

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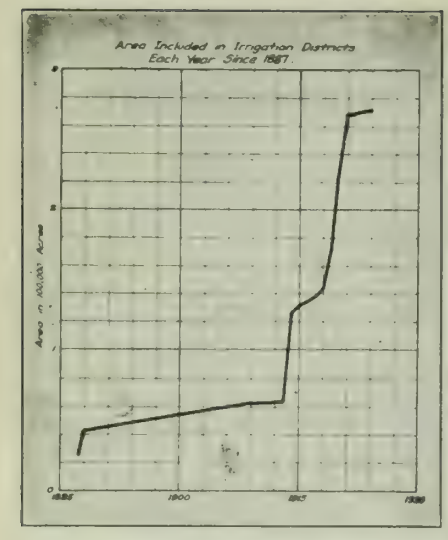


Area included in irrigation districts each year since 1887

will retard settlement. An important influence which delays settlement is the fact that all of the items of cost included in the purchase of land and its improvement are not considered before purchase. Capital requirements for creating irrigated farms exceed the amount possessed by prospective settlers. Anticipation of the effect of over production at times is a retarding element. The tendency to include within projects large amounts of poor land has a most undesirable effect upon the rate of settlement.

Total Costs of Developed Land Exceed Expectations: An important cause of delay in settlement is the failure of settlers to develop farm land at a profit. These failures are poor advertising. Many of them are due to items of cost that the settler does not realize exist, such as future required construction to complete the irrigation works, bonded debts not properly allowed for, and taxes paid before development is completed. The items of cost that make up the irrigated farm are (1) the raw land price, (2) the cost of the irrigation works, (3) the taxes paid before the land can use the water, and (4) the cost of improving and equipping the farm.

The Raw Price

1. The cost of the unimproved land is usually the largest of the four items of cost. Except in the mountain valleys where the growing season is short, or where soils are poor, good grain land having a water supply costs from $100 to $300 an acre. In a given neighborhood wide variations in price exist because of the lack of community co-operation in the sale of land. The community has no deaquate sales policies to protect its interests. The sale of unimproved land should vary with the expected cost of the irrigation works and the cost of improvement. The sale price should, though it does not ordinarily, take into account the bonded debt.

2. The cost of irrigation works has been a small part of the ultimate land cost. This cost is rapidly increasing because the inexpensive projects have been built and from now on costs may seldom be less than $100 an acre. Since few of the projects have been entirely completed, the ultimate per-acre cost of the construction is seldom known. Some lands are served by supplementary projects, drainage, flood protection, or water storage that are constructed at a later date and thus make ultimate construction cost much higher than anticipated when land for settlement was purchased. In considering the purchase of land, an allowance should be made for the cost of the construction still to be provided.

Expense in Taxes

3. A very tangible cost item to the landowner is the expense in taxes and imputed interest paid before the land is producing irrigated crops. In one district only eleven years old, the unimproved land has already cost in taxes and imputed interest over $50 an acre for every acre of land in the district. A district that has delivered water for twenty-five years still has some of its best land unimproved. Another tract has paid $85.87 per acre for district taxes allowing imputed interest on these payments at 6 per cent. The bonded debt assessed against this land is only $20.26. Few irrigation districts will improve all of their lands before the total taxes paid by the unimproved land equal $50 an acre for the total district area, and, in many instances, the amount will be much greater. This means that there will be an expense of $50 for the improvement of these lands that has not been considered. The problem is one of orderly and prompt development of the irrigable lands. This time element involved in development has not heretofore been adequately considered.

4. Finally, the actual cost of improving the land has been considered, and from a study of seventy farms in 1922, it was found that the cost to improve a 40-acre dairy or general farm averaged $153 per acre. The cost of livestock and equipment are not included in this estimate. In the same area costs of developing fruit lands averaged $174 per acre. These farms were developed at very low costs and for best results more capital is needed, often bringing the costs for the development of this type of farm up to $200 an acre. Fruit farms often require the expenditure of $400 per acre when all items are considered.

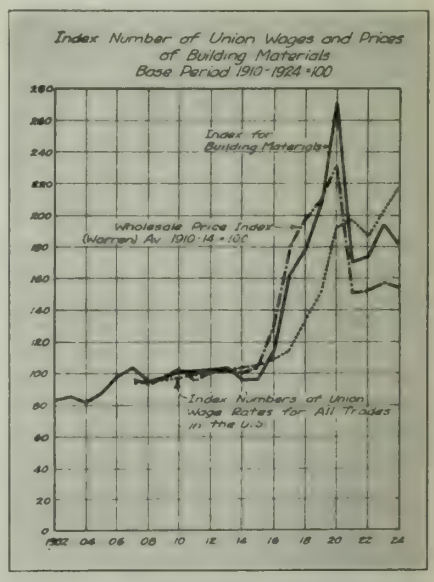
The largest item of cost is usually the purchase price of the land which may vary for good land from $100 to $300 an acre. The cost of improving the land and providing the equipment for the farm is next in importance. The cost in taxes for irrigation service before it can be used is the third largest, and the cost of the irrigation construction is the least of all.

Summary of Costs: The sum of the above items of cost would be somewhat misleading because present sales prices of raw land may include part or all of the costs of interest imputed during the time the land is idle. The owner of the raw land may have been compelled to write off a part of this as a total loss. The settler may assume part or all of this and later write it off or deduct it from his profits. It is a loss to society regardless of the one who pay for it. Common costs of the improved farm, therefore, will ordinarily range between $300 and $700 per acre. These are very ordinary costs which are outside of these values at both extremes.

Skill is Prime Requisite

The development of farm land requires the skill of an engineer and agriculturalist as well as good construction ability. Most farmers improve but one farm in a lifetime, and consequently make many mistakes in farm layout and construction. This accounts for the large amount of work that is poorly or incorrectly done and has to be done over. This is so frequently the case that the waste from this source represents at present an important part of the cost of land development.

Capital Requirements for Land Improvements: Even under favorable conditions of costs, need of capital for farm



Index number of union wages and prices of building materials. Base period 1910-1924= 100.

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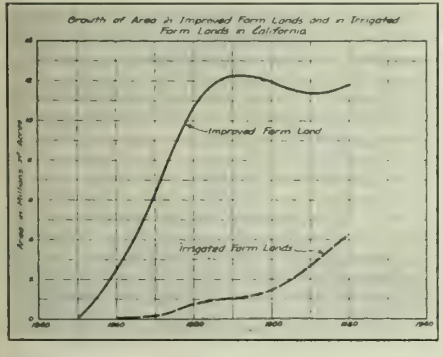
purchase, development and for equipment, livestock, farm operation and living expenses, often results in failure. The expense involved in land improvement emphasizes the fact that a farm is a large investment even where the elements of cost are favorable. The amount of capital that most settlers have will improve but a small part of the farm,—too little to aid materially in the development of the balance. The job partly completed has to be turned from one to another until finally enough land is producing to make the enterprise a profitable one. On a typical 34-acre dairy farm in the San Joaquin Valley gross capital requirements amounted to more than $20,000 and net capital requirements exclusive of the income from the farm, during the four-year development period, amounted to more than $17,500. Economy was exercised in the development of this farm and when it is completely equipped, the total investment will be much greater. Fruit farms re-


Growth of Area in Improved Farm Lands and in Irrigated Farm Lands in California
Improved Farm Land
Irrigated Farm Lands

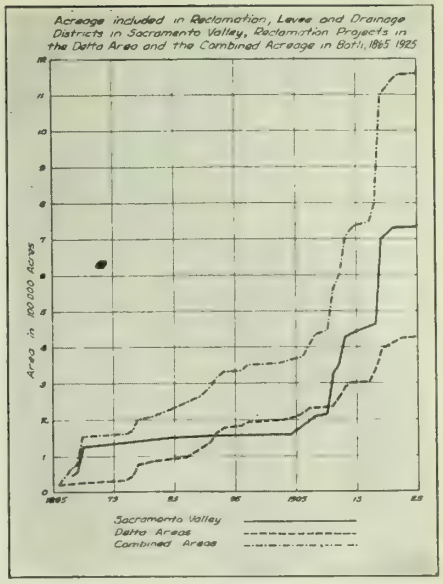
Growth of area in improved farm lands and in irrigated farm lands in California.

quire greater sums and the problem of financing is made more difficult by the length of time it takes an orchard to come into bearing.

Effect of Price Changes Development Costs: To improve land in the peak of high prices (1920), cost nearly double what it would in 1913, or 50 per cent more than it would today. Similarly to construct irrigation projects in times of high prices may make the ultimate cost more than 50 per cent greater than in normal times. Projects constructed in times of a gradual decrease in the general price level extending over many years will require a larger margin between the computed elements and the sale price of land than if the general price level were rising. Large business enterprises consider these movements very carefully. They are as important in agriculture as in other business. Farmers who bought and developed their farms in any year prior to 1919 made improvements under conditions of costs which were as good or better than those which have confronted the farmer making improvement in any year since. The farmer developing prior to 1918 had the added advantage of an increased ability to make repayment during the years 1918, 1919, and 1920 due to high prices for commodities sold. Farmers purchasing farms and improving them in 1919 and 1920 were unfortunate and will be compelled to write off some part of their invested capital from their assets. Farmers purchasing and making improvements in recent post war years may, by carefully planning their programs, have a greater advantage in making repayment than they would have had befor the war. The opposite may be the result, however, from poor selection of types of agriculture, poor choice of land, uneconomical size of farm or unprofitable combination of enterprise.

Over Production: California argiculture has enjoyed unusual. prosperity. Large earnings from highly developed fruit and truck land have stimulated irrigation development and caused rapid increase in irrigation construction. Because much of the land in California is suited to fruit and truck crops, the tendency has been to convert general crop lands into intensively cultivated fruit and truck land as fast as possible. This has raised the question whether California agriculture can in the future maintain the same degree of prosperity. This may be one, but only one, of the causes which is keeping capital and settlers from the improvement of more than a million acres of California irrigable lands. It should be recognized, however, if over production may be classed as one of the fundamental causes of retarded development, that it is only one of the causes and probably not the primary cause, for the lag in agricultural development behind irrigation construction is characteristic of the passed history of irrigation through periods of prosperity and periods of depression. Over production may aggravate the situation at certain times. A study of crop adaptation from an economic as well as a physical standpoint should help in the solution of this problem. It is still possible for some farmers to develop farms and obtain attractive remuneration for their work.

Land Qualities Materially Affect Rate of Development:—The greater proportion of the best soils have already been provided with irrigation facilities. Future irrigation projects will have increasing amounts of soils of poorer quality, less productive and more difficult to prepare for irrigated farming. In one-third of the districts of California, there is very little unirrigable land. In ten districts from ten to twenty per cent of


Acreage included in Reclamation, Levee and Drainage Districts in Sacramento Valley, Reclamation Projects in the Delta Area and the Combined Acreage in Both, 1865-1925
Area in 100,000 Acres
Sacramento Valley
Delta Areas
Combined Areas

Acreage included in reclamation, levee and drainage districts in Sacramento Valley, reclamation projects in the delta area and the combined acreage in both, 1865-1925

the assessed area is unirrigable. In eight from twenty to thirty per cent is unirrigable while in four from thirty to forty per cent of the assessed area is not capable of irrigation.

Large Projects, Big Problems

Policies of Irrigation and Agricultural Development:—The state is now facing the construction of very large and expensive projects, including three large water storage districts that will control the entire water supply of the largest tributaries of the San Joaquin River. The larger projects become, the greater the economic problems they involve. It will take longer to settle the land, and with increased costs of irrigation works and land development, more capital and skill will be required for success. This will make it more difficult to find settlers. If these projects are to be built with capital bearing interest, a large element in the success of the projects will be the accuracy with which the time required for settlement can be gauged and estimates of the cost of delay computed. These projects must be studied with reference to the trends of agricultural production of the crops adapted to the projects and with reference to the general trend in business conditions.

The problem of coordinating agricultural and irrigation development is a difficult one. Even those opposed to the extension of agriculture will agree that prompt settlement of a project, once it is begun, will save great wastes to farmers and to society. The problem is one, then, of constructing only projects, which are feasible, when all of the elements of cost are considered, and of developing

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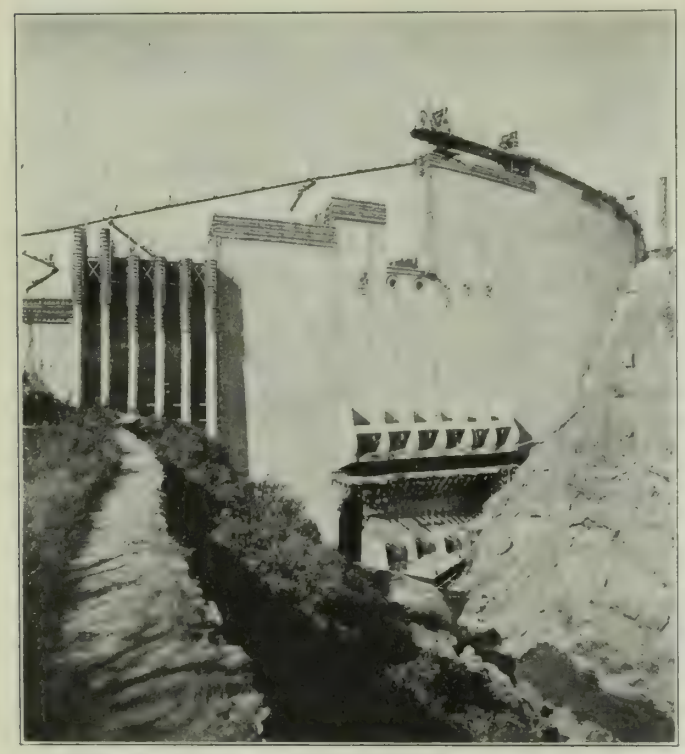

Upstream face of Don Pedro Dam.

Don Pedro Dam

How It Was Built And What It Cost

By C. E. PEARCE*

THE TURLOCK Irrigation District is in the San Joaquin Valley of California, and is approximately one hundred miles east of San Francisco. It is the oldest irrigation district organized under the Wright Act of California, which act authorizes the formation of irrigation districts upon a vote of the people, and authorizes such a district to levy an irrigation tax, based upon an assessed value of the land, in order to obtain money for carrying on the business and construction program of the district.

The district was organized in 1887. In the same year the Modesto irrigation district was formed, and shortly after that, the La Grange dam was built jointly by the two districts.

At this point it will be well to describe the general topographic location of the two districts and their relation to the river from which they both obtain water. The Sierra Nevada mountain range runs in a general direction north and south, and forms the eastern boundary of the San Joaquin valley (south of San Francisco Bay) and the Sacramento valley (north of San Francisco Bay). The two valleys really constitute one valley basin which is called by geologists "The Valley of California." The San Joaquin river flows northerly, and the Sacramento river flows southerly. They meet at San Francisco Bay and jointly flow into the Pacific Ocean through the narrows of Golden Gate. All along the Sierra Nevada range, there are various rivers; such as the Mokelumne, Tuolumne, Stanislaus, Merced, Kings, etc., flowing westerly down the western slope of the mountains until they meet the main arterial river, the San Joaquin, where their waters are turned in that river towards the Pacific.

Topography of Valley

The San Joaquin valley, though it looks perfectly flat, is a slightly inclined plane rising gently from the San Joaquin river to the foothills of the Sierras. It is the existence of this inclined plane, and its degree of inclination, that makes gravity irrigation possible and successful. The Turlock irrigation district is on one of these planes.

The Tuolumne river flows out of the Sierra Nevada mountains near the town of La Grange, an old mining town, and then continues westerly a distance of about twenty miles down this inclined plane to the San Joaquin river. In this twenty mile stretch, the Tuolumne has cut its way down into the inclined plane during the past ages until at present it is a gorge about a quarter of a mile in width, the river channel itself being in the bottom lands of the gorge, so that at the river for most of its 20-mile length on the inclined plane, one gets the impression that the San Joaquin Valley is a sort of an elevated plateau or table land, from fifty to a hundred feet above the elevation of the Tuolumne river bottom lands. It is plain that the relation between the river and its surrounding country would make pumping by irrigation costly, as well as not providing storage.

Districts Build Joint Dam

The Turlock and Modesto irrigation districts adjoin each other; the Modesto district being north of the Tuolumne river and the Turlock district south of it. They have, therefore, jointly built a diversion dam, the La Grange dam, across the Tuolumne river a short distance above the town of La Grange. This dam is located far enough up in the foothills that water leaving it by a diversion canal on the canyon slopes emerges from the canyon high enough to deliver water to the upper edge of the previously mentioned inclined plane (or the eastern edge of the San Joaquin valley), and from there, for the Turlock district, the water flows by gravity in main canals, high-line canals, and laterals, westerly and southerly, delivering water to the district.

There has also been built a foothill storage reservoir, the Owens reservoir, at the upper edge of the inclined plane, where the main canal from La Grange dam emerges from the river canyon. We then have a diversion dam, a side-hill canal, and a foothill storage reservoir which feeds main canals and laterals, the whole constituting an ideal gravity system.

In 1923, the Turlock and Modesto irrigation districts finished another dam jointly, the Don Pedro dam. This structure is about nine miles up the

*Civil engineer with Turlock Irrigation District during construction of Don Pedro Project.

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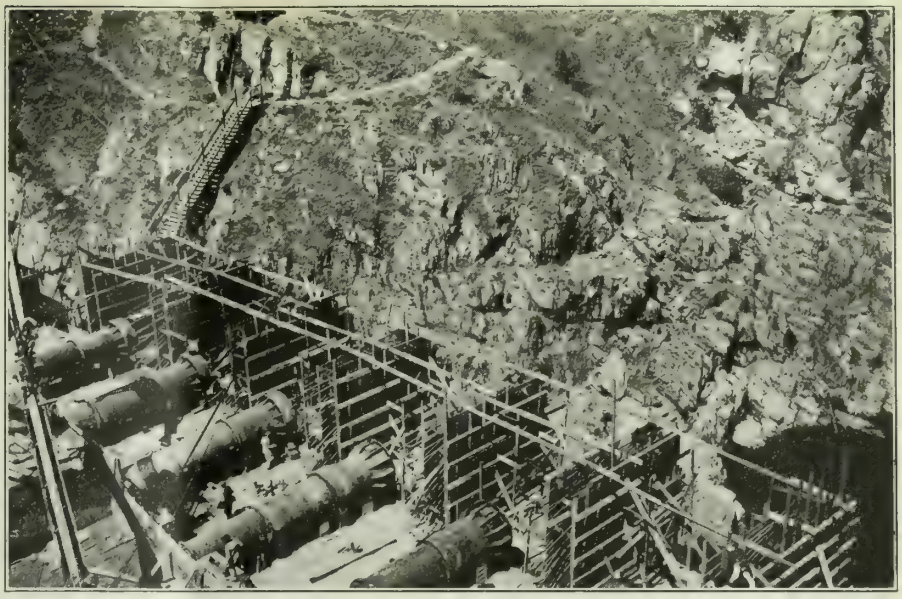
Tuolumne River from the La Grange dam, and is essentially for impounding storage, with a capacity of 289,000 acre-feet. The storage water, on leaving Don Pedro Reservoir through the dam is, however, used for developing electric power, the sale of which helps materially in paying for the cost of the project.

This Don Pedro storage reservoir forms another link on the upper end of the gravity system. The water from it is let out in the summer, flows down the natural river channel to the La Grange dam (diversion dam), and from there follows the course already described. If the run-off permits, and it ordinarily does, there are then two reservoirs full when the irrigation season begins.

Lower Power House

In controlling the operation of the Don Pedro reservoir and power plant, it was noticed that during the late autumn and early winter months (say from October to December) when irrigation was not required, the reservoir had been drained low from the summer's irrigation, and the resultant power output was low because of a small head on the power plant. The water which was used for power, however, had to go one of two places: either wasted over the La Grange dam, or diverted by the La Grange dam into the irrigation canals, where it was not needed. It was therefore decided to build a power house a short distance below the La Grange dam.

In order to do this the Turlock main canal was enlarged to form a forebay a short distance below La Grange dam, and then the water was dropped down the hillside to the river about a hundred feet below through a small power plant,— thereby utilizing the full height of La Grange dam and supplementing the power supply of the system during a time when the output was low. In addition to producing more power, this plant increases the available load factor for the system, which is again worth money.



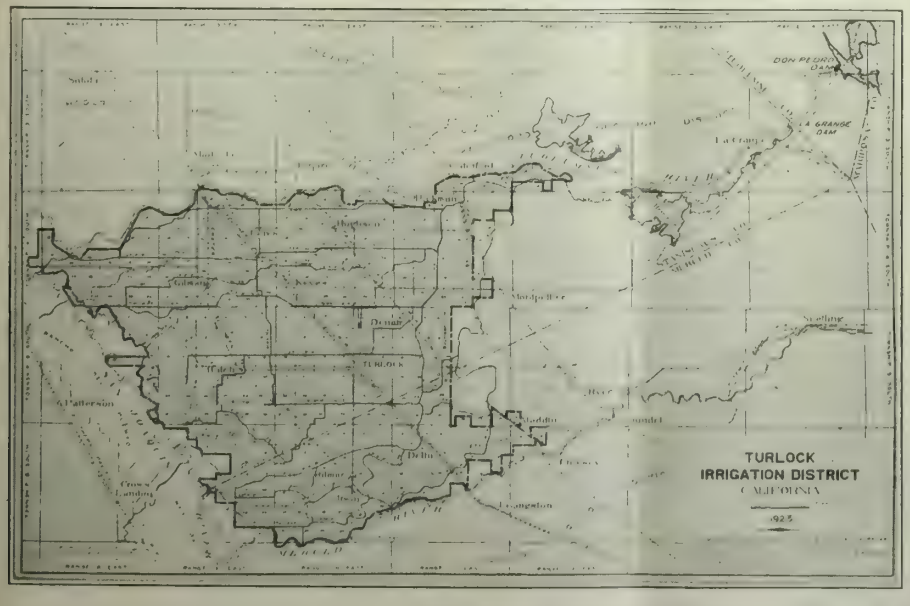
Setting lower irrigation inlets.

Don Pedro Dam

In 1923 the Don Pedro dam and power plant were finished. This dam is of the gravity type, arched in plan with an upstream radius of 674.7 feet, is 284.1 feet high and was the highest dam above stream bed at the time it was built, there being practically no excavation required below stream bed. The dam was designed according to the so-called "Wegman Method," considering parallel planes and no uplift. Provision was made, however, for preventing and relieving uplift by grouting and providing drains, respectively.

The dam contains inspection galleries near the upstream face and as near to foundation rock as possible. On one side of these galleries, there are gutters, and into these gutters the drains from the foundation discharge artesian-like. These vertical drains are 8 inches in diameter from bed rock to the gutter, and below bed rock they are 5 inches in diameter, and were drilled 20 feet into rock at 10 foot centers. Just upstream these drains, in the bottom of a cut off trench at the upstream toe, there were drilled two rows of 3-inch grout holes 20 feet deep. The holes were at 10-foot centers and staggered in the two rows. Grout was forced under pressure into the holes. The maximum pressure on the inclined joints at the downstream face of the dam varies from 4.42 tons per square foot near the top to 29.96 tons per square foot at the bottom; and the maximum pressure at the upstream face varies from 2.07 tons per square foot near the top to 21.56 tons per square foot at the bottom.

For draining the upper part of the structure, a line of 8-inch diameter vertical drains, at approximately 10-foot centers near the upstream face of the dam, were cast into the concrete of the dam by the use of slightly tapered greased poles. These drains discharge into the galleries below. One such well was also placed on each contraction joint downstream from the contraction-joint copper water seal near the upstream face of the dam. Certain of these drains passing near the positive control irrigation outlet valves are also used as



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Beginning of operations after completion of footings.

air inlets. The drainage water delivered to the gutters is carried along the galleries and discharged freely at the down-stream face of the dam.

Details of Construction

Vertical contraction joints were placed in the dam as follows: at 130-foot centers there are joints which extend from top to bottom: midway between two such joints there is a joint which extends from the top to a point approximately half-way down to the foundation; and midway between this center joint and the full-height joint on either side, there is a joint which extends from the top to a point approximately one-third the way down to the foundation. This system provides contraction joints at 130-foot centers at the bottom, 65-foot centers half-way up, and 32.5-foot centers at the top. Each joint is provided with a copper water seal of the common bellows type.

The outlets in the dam are as follows: six 52-inch diameter upper irrigation outlets at elevation 1,070 (top of dam parapet being at elevation 1,172 and stream bed at elevation 883.9); six 52-inch diameter lower irrigation outlets at elevation 980; three 60-inch diameter sluice outlets at elevation 914; and three 72-inch diameter power outlets.

All twelve of the irrigation outlets are controlled at the upstream face by 58-inch Ensign balanced valves. Three of of each tier of six have an addition of positive control, and all of the valves are supplied with water in a 4-inch pressure line to insure operation. The inspection galleries form the operating chambers, and are about 16 feet from the upstream face of the dam and just under the outlets. The sluice outlets are controlled, by hydraulically operated slide gates. The operating chamber for these gates is a gallery near the upstream face of the dam and just over the conduits. The power conduits are operated by the same size slide gates, operated in the same manner.

Side-Channel Spillway

The spillway is of the side-channel type. It is controlled by 10 drum type gates each 57 feet long. The drum gates are operated from piers 6 feet, 3 inches wide between the gates. Water from the reservoir is let into a chamber under the gate by means of a valve operated from the top of the pier. If it is desired to hold the drum gate partially open, some of the water in the chamber is released by valve control into the spillway channel, thereby releasing the pressure in the chamber. Any desired pressure, and consequent position of gate, can be obtained by regulating the inlet and outlet of the pressure chamber. The gate is brought into any desired position by trial. The inlet and outlet valves are 2 feet square.

Cost Report, Don Pedro Dam

	Labor	Material	Labor and Material	Amount of General Overhead & Depreciation Prorated	Credits from Mess Hall & Commissary Cleared to Labor Accts.	Net Cost of Feature Divisions of Project
C-13 Diversion & Care of River	$ 9,083.74	$ 3,698.47	$ 12,782.21	$ 4,872.19	$ 624.05	$ 17,030.35
C-14 Clearing Dams & Spillway bases	329.30	50.00	379.30	144.58	22.62	501.26
C-17 Solid Rock Excavation	95,550.50	20,663.21	116,213.71	44,297.18	6,564.31	153,946.58
C-20 Solid Rock Excavation Spillway	150,997.02	65,501.67	216,498.69	82,522.80	10,373.49	288,648.00
C-24 Diversion & Care of Power Ditch	2,174.49	1,603.77	3,778.26	1,440.16	149.39	5,069.03
C-32 Extra Forming & Finishing Waterways	17,984.51	3,277.30	21,261.81	8,104.36	1,235.54	28,130.63
C-34 Placing Copper Seals	1,003.24	1,418.56	2,421.80	923.12	68.92	3,276.00
C-35 Vertical Drains	4,819.03	98.31	4,917.34	1,874.34	331.07	6,460.61
C-36 Concrete Steps Spiral Stairway	1,749.15	2,103.36	3,852.51	1,468.46	120.17	5,200.80
C-38 Drilling Grout Holes	12,212.28	5,849.73	18,062.01	6,884.70	838.98	24,107.73
C-41 Drainage Wells	4,466.67	1,270.85	5,737.52	2,186.97	306.86	7,617.63
C-42 Laying Split Tile Drain	600.00	330.63	930.63	354.73	28.96	1,256.40
C-45 Mass Concrete in Dam	217,454.41	1,317,527.91	1,534,982.32	585,089.22	15,556.00	2,104,515.54
C-49 Trash Racks	1,823.73	8,028.17	9,851.90	3,755.25	125.29	13,481.86
C-50 Balanced Valves	7,864.80	126,068.80	133,933.60	51,065.79	540.31	184,459.08
C-51 Sliding Valves	854.24	30,058.98	30,913.22	11,755.66	58.69	42,610.19
C-52 30" Cast Iron Pipe	479.69	2,059.00	2,538.69	967.67	32.95	3,473.41
C-53 30" Gate Valve & Needle Valve	153.87	4,947.30	5,101.17	1,944.41	10.57	7,035.01
C-56 Reinf. Concrete in Struct. on face of dam	36,347.03	80,593.13	116,940.16	44,573.13	3,998.18	157,515.11
C-61 Spillway Bridge	6,655.79	10,350.29	17,006.08	6,482.21	474.23	23,014.06
C-55 Misc'l Hardware		2,696.45	2,696.45	1,027.42	86.71	3,637.16
C-69 Electric Conduits	855.84	1,860.68	2,716.52	1,035.45	58.80	3,693.17
C-70 Lamp Pedestals	851.10	1,197.05	2,048.15	780.69	58.47	2,770.37
C-71 Approach to Dam	5,239.54	2,238.66	7,478.20	2,850.46	359.96	9,968.70
O-3 Excavation of Penstocks	41,020.44	15,317.86	56,338.30	21,474.47	2,818.10	74,994.67
O-5 Power House Concrete	42,739.05	51,949.40	94,688.45	36,092.39	2,936.17	127,844.67
O-8-9 Power House Material Equipment & Machy	47,031.33	371,597.58	418,628.91	159,568.59	3,492.96	574,704.54
O-10 Sliding Valves		30,840.99	30,840.99	11,755.66	58.69	42,537.97
O-11 Spillway Gates	12,271.13	54,399.80	66,570.93	25,374.84	843.03	91,102.74
	$722,611.92	$2,217,497.91	$2,940,109.83	$1,120,666.90	$52,173.47	$4,008,603.27

Cons. cost of Dam & Spillway	$3,097,418.68
Cons. cost of Power Plant	911,184.59
TOTAL	$4,008,603.27

"Western Waterworks" Begins on Page 25

Report of Estimates and Costs Don Pedro Dam Project

ESTIMATES

Don Pedro Dam	$3,570,000.00
Power Plant	709,000.00
	$4,459,000.00
Exchange of 10,000 KWH yearly for Right of Way, etc.	380,676.00
	$4,839,676.00

BOND ISSUE

Bond Issue Modesto I. D. Dam	$1,180,000.00
Bond Issue Modesto I. D. Power Plant	223,618.60
Bond Issue Turlock I. D. Dam	2,570,000.00
Bond Issue Turlock I. D. Power Plant	485,381.40
	$4,459,000.00
La Grange Power Plant water rights, ditch, etc., for which Districts exchanged 10,000,000 KWH yearly for a period of 25 years	380,676.00
	$4,839,676.00

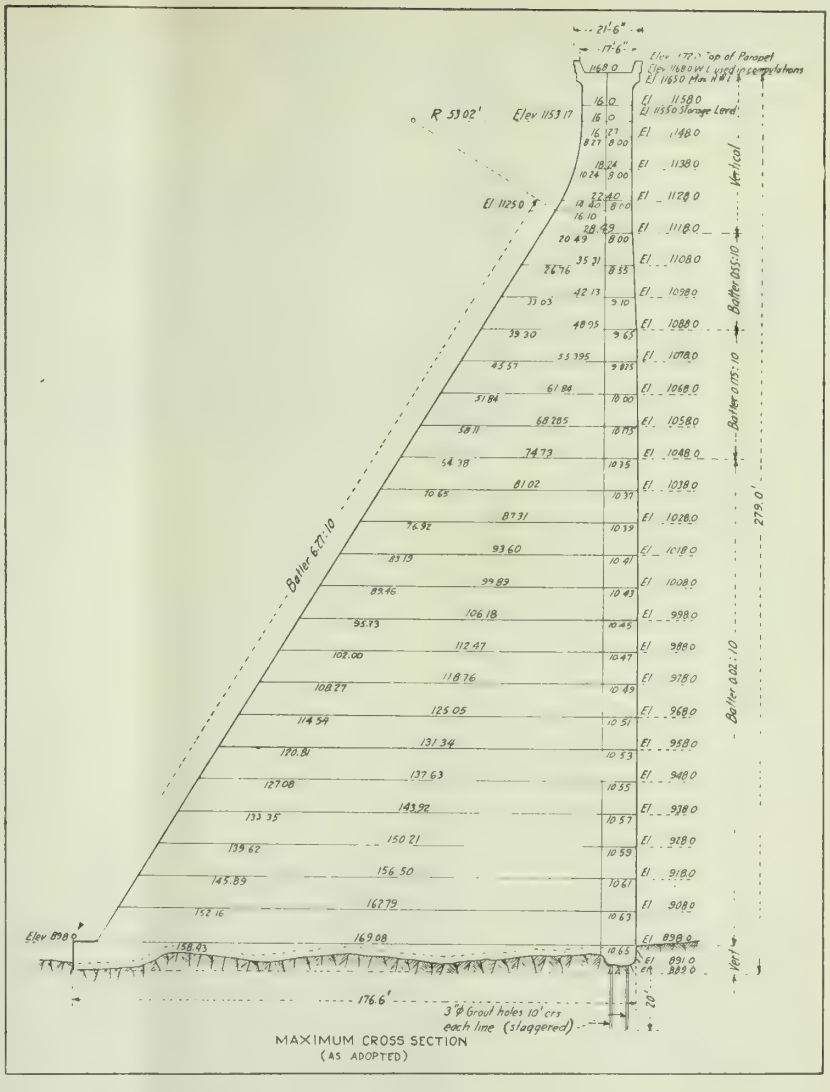
COST OF PROJECT

Don Pedro Dam	$3,097,418.68
Don Pedro Power Plant construction	911,184.59
La Grange Plant, etc., as above	380,676.00
Rights of Way and land purchases	220 555.82
Six Bit Gulch Bridge	88,364.26
Water Rights	4,703.56
Bronze Plate	210.00
Roads, Bridges and Trails	13,593.71
Cottages	14,932.07
Domestic Water System	4,651.60
Telephone System	7 823.31
Bills Receivable	127,985.87
Inventory of equipment and supplies	15,518.87
	$4,887,618.34
Reserve for possible bad accounts and future obligations	22,794.00
	$4,864,824.34
Accounts receivable $ 127,985.87	
Equipment & Supplies 15,518.87	
$ 143,504.74	
Less reserve account 22,794.00	120,710.74
	$4,744,113.60
Total estimate $4.839,676.00	
Net Cost 4,744,113.60	
$ 95,562.40	

Don Pedro Project Unit Costs

278,810 cu. yds. Mass Concrete	7.39	$2,061,592.76
3.000 cu. yds. Reinforced Concrete	14.23	42,922.78
28.600 cu. yds. rock excavation in dam foundation	5.38	153,946.58
26,000 cu. yds. Loose rock and 116,000 cu. yds. Rock in spillway Excavation	2.03	288,648.00
7,210 cu. yds. Rock Excavation Power House Penstock Tunnel Tailrace and Portal	10.41	74,994.67
3,400 cu. yds. Reinforced Concrete in Power House	37.60	127,844.67
13,440 cu. yds. Reinforced Concrete in Spillway Structure	11.71	157,515.11

These costs are final and cover all overhead, railroad and equipment costs of every kind and description and have been credited with their proportion of a profit of $52,173.47 from the commissary and mess hall operations.



Maximum Cross Section, Don Pedro Dam

The time required to open or close the drum gate is only a matter of how long it takes to fill or empty the pressure chamber through these valves. An estimate of the period required, from observation, would be about five minutes. The gates move fast enough to be easily visible to the eye. By the use of these gates the water level in the reservoir is raised 9 feet. The tops of the operating piers are accessible through a gallery under the spillway crest. In each pier there is a shaft, with a ladder, to the gallery. The gallery is entered from the dam or from the most upstream spillway pier, said pier being accessible by a concrete arch footbridge. The top of the dam is a roadway 16 feet wide, and this roadway is carried across the spillway channel by means of a steel arch bridge encased in concrete. A steel arch bridge was cheaper than concrete arch with false-work. In addition, the elimination of false-work permitted the continuation of spillway excavation by the steam shovel while the bridge was being built. The ten gates which were built by the Union Construction Co., of Oakland, California, weighed 582,122 pounds and cost $43,260.00 which amounts to 7.4 cents per pound f. o. b. cars Don Pedro dam.

Power House Described

The power house is built at the downstream toe of the dam and integral with it. The power house is accessible either from the hillside or through the inspection galleries in the dam, though the latter are used almost exclusively.

Natural laws provide ventilation and cool air for the power house in an interesting way. The evaporation from the damp walls of the galleries causes the air in them to cool and drop. Warm air is drawn into the portals higher up, it in turn is cooled and drops, and so on, so that there is a cool draft delivered to the power house by a large ventilation gallery between the power house and the lowest point of the inspection gallery. The power plant has three Francis type turbines and develops 17,000 horsepower. Another unit is now being installed.

The Turlock district does not deliver water to every quarter-section (or similar small division) as some districts do. It has the advantage of reducing the tax rate by allowing the farmers to do their own maintenance during winter months when they have slack periods in their farm work. The Merced irrigation district on the other hand (as well as some other districts) delivers water to every quarter-section. This system also has

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MacDonald & Kahn-Edwards, Wildey & Dixon are Lowest Bidders on San Gabriel Project

Submit Figure of $9,946,710 on Proposal 1 and 9,621,710 on Proposal 2; Last Minute Protest May Cause Hitch

BIDDING on the San Gabriel dam, proposed Los Angeles County flood control project, has aroused unusual interest, and unofficial experts have been busy in an endeavor to analyze the various proposals submitted to the Board of Supervisors of the flood control district on July 11.

San Gabriel dam is the largest single project ever submitted for competitive bids in Los Angeles county. To those conversant with the financial problems involved in an undertaking of this magitude—a structure which will involve the placing of over 3,260,000 cubic yards of mass concrete—the small number of bids received was not unexpected. Many engineers and contractors were surprised to learn, however, that the majority of the bids were submitted by local construction firms. It was thought that, on account of the size of the contract, many of the large eastern and middle-western firms engaged in this class of construction would be attracted, and that the job might go to one of them. A number of these firms did look over the job, but only one submitted a proposal. Why others did not bid, is only a matter of conjecture in the absence of any explanation from their representatives.

The bidding covered three different proposals which were prepared by the engineers of the flood control office. The first required that the contractor supply all concrete aggregate, the second that the contractor supply 50 per cent and the district 50 per cent, and the third that the district supply all concrete aggregates. All cement, in each proposal, is to be supplied by the district. For purposes of comparison, the unit bids on proposals 1 and 3 are given below.

Just before the bids were opened, a protest against the construction of a dam lower than originally planned was voiced

(*Continued on Page 50*)

Unit Bids, Proposals 1 & 3, San Gabriel Dam, Los Angeles County Flood Control Project

	PROPOSAL NO. 1				PROPOSAL NO. 3			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1 475,000 cu. yds. river wash excavatioon	$ .98	$ 1.85	$ 2.10	$ 2.50	$ .98	$ 2.10	$ 2.50	$ 2.00
2 875,000 cu. yds. open cut excavation	1.74	2.44	2.40	3.20	1.74	2.40	3.20	4.00
3 435 ft. spillway tunnel complete	80.00	98.00	105.00	600.00	80.00	105.00	600.00	60.00
4 3,250,000 cu. yds. mass concrete	2.29	2.37	3.25	3.25	2.19	2.95	2.90	1.85
5 10,000 cu. yds. reinf. concrete..	11.00	7.50	18.00	16.50	11.00	18.00	16.00	7.00
6 250 cu. yds. precast conc. trash rack screens	37.00	35.00	100.00	100.00	37.00	100.00	100.00	25.00
7 60,000 lin. ft. drilling 3-in. grout holes	2.00	2.50	2.50	1.50	2.00	2.50	1.50	1.00
8 3000 holes fitting pressure pipes in grout holes	2.00	2.00	3.00	25.00	2.00	3.00	25.00	1.00
9 5000 cu. yds. pressure grouting	17.00	40.00	30.00	80.00	17.00	30.00	80.00	20.00
10 10,000 lin. ft. drilling 3-in. drainage wells	2.00	1.10	2.50	1.50	2.00	2.50	1.50	1.00
11 2000 ft. placing split tile drains	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12 11,000 ft. copper contraction seals, placing	2.25	1.25	2.00	2.00	2.25	2.00	2.00	1.00
13 48,000 ft. forming vertical drains	.30	.10	.75	1.80	.30	.75	1.80	.50
14 3000 ft. placing air vent pipe and cut off drain	1.00	.02	1.00	2.00	1.00	1.00	2.00	1.00
15 1,300,000 lbs. placing reinf. steel	.01¼	.01	.03	.04	.01¼	.03	.04	.01
16 210,000 lb. placing steel trash racks	.02	.01	.03	.10	.02	.03	.10	.01
17 1,400,000 lb. placing 60-in. steel discharge pipe	.02	.02½	.03	.05	.02	.03	.05	.01
18 145,000 lb. placing 30-in. steel discharge pipe	.02	.02½	.03	.04	.02	.03	.04	.02
19 560,000 lb. erecting gates and valves	.02	.02½	.03	.10	.02	.03	.10	.02
20 3420 ft. placing single pipe rail in galleries	.50	.65	.60	.50	.50	.60	.50	1.00
21 1700 ft. placing double pipe rail in galleries	.50	1.20	1.00	1.00	.50	1.00	1.00	.....
22 2500 ft. placing ornamental metal rail face of dam	1.50	2.00	2.00	2.00	1.50	2.00	2.00	1.00
23 8000 ft. placing electric conduit	.10	.01	.30	.50	.10	.30	.50	.20
24 1000 lbs. erecting gallery doors	.10	.25	.03	.20	.10	.03	.20	.02
25 5000 lbs. erecting misc. metal work	.10	.10	.10	.10	.10	.10	.10	.05
26 55,000 sq. ft. extra forming *and* finishing surfaces	.25	.45	.20	1.00	.25	.20	1.00	.50
27 100 cu. yds. plain stairways	30.00	5.00	20.00	50.00	30.00	20.00	50.00	10.00
Total Bid	$9,946,710.00	$11,333,308.00	$14,440,807.00	$15,975,310.00	$9,621,710.00	$13.465,807.00	$14,832,810.00	.....

Key: (1) MacDonald & Kahn and Edwards, Wildey & Dixon; (2) C. J. Kubach Co., and Claude Fisher; (3) Utah Construction Company; (4) John Griffitffhh & Sons Company; (5) MacDonald & Kahn and Edwards, Wildey & Dixon; (6) Utah Construction Company; (7) John Griffith & Sons Company; (8) Ross Construction Company.

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Three views of San Antonio's gravity type flood control dam on Olmos Creek. The structure is 1940 feet long.

San Antonio Builds $1,500,000 Dam to Keep Waters of Olmos Creek in Check

Texas City's New Gravity Type Flood Control Structure, 1940 Feet Long and 90 Feet High, Built in Fast Time.*

SAN ANTONIO, Texas, has during its history suffered periodically from overflow of the San Antonio River and its tributary, Olmos Creek. Citizens had more or less grown to expect recurrence of this condition until, in 1921, a flood of unusual height converted the downtown streets into canals and invaded the ground floors of hotels and stores. Thus shaken into seeing the seriousness of the situation, the city voted a bond issue of $2,000,000 for flood prevention.

After a thorough investigation the decision was made to build a detention dam across Olmos Creek near the city, thus checking and regulating the rapid runoff from the 32.4-mile drainage area above. The plans called for a gravity-type concrete dam, crossed by a 24-foot roadway supported at the downstream side by columns and arched girders of pleasing architectural design, and highway approaches skirting the reservoir area.

The Dam and Reservoir

The dam proper as finally constructed has an over-all length of 1,940 feet and a maximum height of 90 feet. The gravity cross-section was proportioned to take care of a full static head of water plus an assumed uplift of one-half the static head at the heel and nothing at the toe. Additional provision for uplift was made by providing two lines of relief wells discharging into an inspection tunnel which runs the full length of the dam.

The discharge is through six 8 by 8-foot conduits of rectangular cross sections located near the center of the dam, shown in the view at the bottom of the second page. Just above this outlet, it may be seen, the channel of the stream has been riprapped to confine the low water flow. The conduits are each fitted with a vertical acting gate operating independently or interchangeably, either electrically or by hand.

Aprons built below the conduits are designed to fit the paths of jets under the maximum head, in this way practically eliminating friction. The energy of the discharge will be dissipated by a hydraulic pump in a pump chamber at the foot of the apron.

The detention reservoir covers a maximum area of 1,045 acres and has a storage capacity of 5,390,-550,000 gallons or about 16,500 acre-feet. This area will be dry much of the time as the sole purpose of the project is to regulate the sudden flow following heavy rains during the flood season.

The 24-foot roadway is built with one railing resting on cantilevers extending 6 feet upstream from the vertical backwall of the dam and the other railing supported on arches and columns built up from the face of the dam.

The two approaches follow the high

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The EDITORIAL

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RUSSELL R. PALMER
Editor

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Thanks

MODERN IRRIGATION'S first annual hydraulic dam number, published last month in response to a long-felt need of hydraulic engineers and others interested in irrigation development, has had a reception that is indeed gratifying to the editors of this journal. Letters of commendation have been received from practically every country on the globe interested in water development; and responses are just now coming in from Australia on the other side of the world. It would be impossible to print every comment received, but the tenor of all is that the publishers of the magazine have added an important document to irrigation literature.

While we are happy to receive these kind expressions we are not unmindful of the shortcomings of this initial attempt to produce an annual hydraulic dam number. Many improvements are possible and will be made in succeeding annual issues. The pioneering work has been accomplished and with the support that has come from readers everywhere we can lend ourselves with confidence to greater efforts in the months and the years to come.

Co-operation Pays

THE Irrigation Districts Association of California has prepared an excellent summary of the bills affecting irrigation districts passed at the last session of the California Legislature. Most of these measures became effective July 29. In addition, the association has prepared a list of bills—eighteen in all—also affecting irrigation districts which were opposed by the association. None of these became a law.

The Irrigation Districts Association of California is a mutual association of irrigation districts organized under the California Irrigation District Act and its purposes are for the mutual benefit of irrigation districts and the advancement of California through the proper use and distribution of the waters of the state. It is, as its record at Sacramento shows, fulfilling its purposes well and it deserves the support of all California districts for the battle it wages biennially in the interests of rational irrigation development and management in the state.

The organization now has as members districts comprising about 85 per cent of all the acreage in irrigation districts in the state, but its work is for the benefit of all. The association should, therefore, have the 100 per cent allegiance of California districts. Considering the great good that is being accomplished the cost of membership is small.

A Neglected Problem

IRRIGATION projects of the magnitude now constructed in the West involve a large investment extending over a long period of years. The engineering feasibility of these projects is carefully determined and detailed study made of that part of the construction costs to be undertaken in the ensuing ten or fifteen years; but the agricultural and financial problems of the individual and the economic and agricultural problems of the project as a whole are, in many cases, scarcely considered.

In irrigation construction there must come the realization that the risk both to the individual and the project administration is greater and demands more study and planning than all other phases of the problem. This risk will increase with the growing magnitude of the projects.

Very little literature has been produced dealing with the economics of irrigated agriculture. For this reason, we believe, the reader will want to give particularly close attention to the article in this issue of the magazine by David Weeks and Charles H. West, who, in co-operation with the Federal Land Bank of Berkeley, have prepared a discussion of the problem of securing closer relationship between agricultural development and irrigation construction.

The history of irrigation development from the standpoint of the settler has never been written. Such a history would be a valuable aid to those who must undertake the development of farms in the future. One of the purposes of Messrs. Weeks and West in the preparation of their article was to present detailed information as a guide to farmers anticipating the purchase of land in irrigation projects of California.

Farming is a business, but it

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POINT *Of* VIEW

was not until the close of the war that serious attention was given to the problem of the settler and the relation of the cost of irrigation to the cost of farm development. We are just beginning to realize the difficulty of the problem confronting the settler. Many projects are rated as successes even though a large proportion of the original settlers failed, because, eventually, after writing off the losses and making the necessary adjustments, farming became more profitable and flourishing communities were established.

In considering the success of the community, the failures of the individual have been overlooked. If, however, by planning, regulation or education the growth of agriculture under irrigation may take place in such a manner as to be more profitable to the individual, the results will be beneficial to the state in every way.

Membership in Societies

THE engineer considers himself competent to organize certain industries, but he has not demonstrated the ability to organize effectively his own profession. Instead of one comprehensive organization designed to deal *in all matters* with which engineers are concerned, we find many groups, which have formed as many societies, busied principally with professional and social matters. Intolerance, lack of foresight or inability to get on with their fellows has caused each group to seek opportunity for self-expression by forming a separate organization devoted to the particular interests of the group. The splitting-off process continues and will continue unless the engineers awake to the harm it is doing.

Engineers, more than any other group, find difficulty in composing their differences, in harmonizing their efforts. True the four great founder societies are learning to work together, somewhat as the result of the efforts of the great iron master, but harmony has come slowly, and not without jealousy and suspicion. The lesser groups are more or less ignored and some of the newer ones are materially antagonistic to the older organizations.

The differentiation should have never taken place; the profession should have developed as one all-inclusive unit, which, by numbers, by its ability to speak for all engineers, as the bar association speaks for lawyers, could exert the whole weight of the profession in industry and in public affairs.

The profession is not yet entirely apart from the trades from which it arose. It is true that within fifty years great numbers have been graduated from our technical schools and have been received into the various technical societies on the basis of that schooling; but so many competent men are self-educated in the trades that our engineering societies also provide for their admission to membership. The only assurance of their character or professional training, as well as the fitness of all candidates for the higher grades of membership, is the judgment of five members of the society, whose opinions may be more generous than sound.

We have a place in our industrial life for every grade of engineer and the founder societies have rightly established appropriate grades of membership covering them. The British societies receive proportionately fewer university trained men, but assure themselves of the candidate's fitness by requiring him to pass an examination before he is given the professional status membership confers. Engineering societies in this country might well pursue a like course, so that membership in any grade of the founder societies would establish a man's professional status with some degree of positiveness.

"White Gold"

THE story of the irrigation of the Turlock District in California is one that illustrates how wealth can be developed in a community by the judicious application of water. There have been failures in the west in the formation, financing or development of different irrigation districts, but there have been successes, too, and Modesto-Turlock is one of these.

Under dry farming methods a total of 140 ranches, averaging 1,250 acres, struggled for existence in this district. With the coming of water, the district now supports 4,000 farms having an average size of 40 acres. In the pre-irrigation period, the rural population was about 800; now it is 12,000. The town of Turlock, which had a population conservatively estimated at 150 in pre-irrigation days, is now a modern thriving city of over 6,500.

These figures do not tell the whole story. The rural population has dropped from an average of five persons per family to four per family. Market values of the land before irrigation averaged but $25.00 per acre. The same land sold for $200.00 per acre, when placed under water. The value of farm crops jumped from $1,660,000 for the pre-irrigation period to over $22,000,000 for the post-irrigation period.

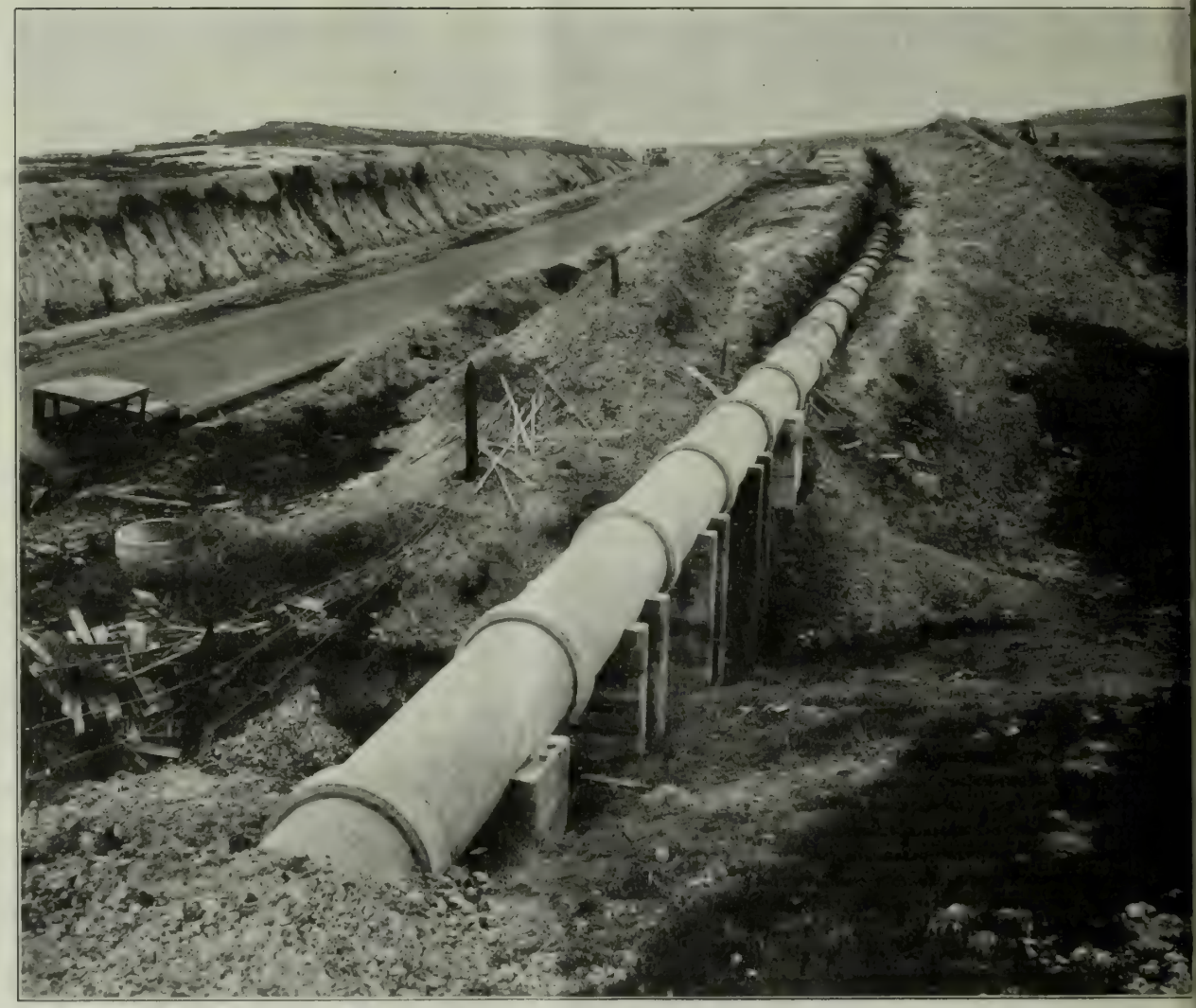
To realize fully what irrigation has done to the Modesto and Turlock District, one should attempt a mental picture of conditions prior to the formation of the district. Similar conditions are still to be found in many parts of the west, where irrigation water cannot or has not yet been developed.

Farming is often said to be "a mode of living." If this is so, then the real test of a farming section is to be found in the home building of its people. The pre-irrigation days found a desolate country, sparsely settled with an extremely poor type of home. Today, in this irrigated district the rural home is as modern and well kept as the city dwelling. The bringing of water to the farms has brought a great change. The farms look prosperous, and figures of the local district banks justify that appearance. There is truth in the statement that irrigation water is "white gold."

"Western Waterworks" Begins on Page 25

Hume Centrifugally

The Modern Pip



A line of 27″ Hume Pipe crossing an arroyo on the Laguna Beach County Wate District Line.

J. B. LIPPINCOTT CO., Los Angeles, *Engineers*

WESTERN CONCR

LOS ANGELES P. O.

"Western Waterworks" Begins on Page 25 ☛

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New Installations at Riverside Gerber and Ventura
Only Machines for range and square corner ditches.

Don Pedro Dam—How It Was Built and What It Cost

(Contiued from Page 17)

its points. Due to the long-period bond issues, it essentially borrows money for the farmer, and provides him ditches so that he may develop all of his land at once at small first cost, the theory being that the extra crops he is able to raise will more than pay the interest on the money.

The success of the Turlock irrigation district is known to a great many people in the West, and is looked upon by engineers as a fine example of engineering planning and management. In the dry year of 1923-24, the driest year in the history of California, the Turlock canals were flowing full all summer and the fields were green with alfalfa when irrigable lands in other parts of the state were dry and parched because of lack of storage or irrigation at all. This particular dry year markedly demonstrated the value of irrigation from storage. The district canals, however, are full every year, providing abundant water for the farmers.

The personnel in the construction of the Don Pedro project consisted in R. V. Meikle, chief engineer; Percy F. Jones, associate engineer; A. J. Wiley, consulting engineer; D. H. Duncanson, general superintendent; Ross White, resident engineer; Daniel McFarland, assistant to resident engineer; and L. E. Neel, auditor.

Economic Problems Involved In Irrigated Agriculture

(Continued from Page 13)

a plan of land settlement whereby prompt utilization of irrigation construction will take place. The feasibility of the project can only be determined by careful engineering and economic analyses. Costs incident to the purchase of raw lands and constructing the irrigation works, are no more important than costs incident to holding undeveloped land after construction, and to the improving and equipment of farms. Feasibility surveys must include soil investigations and determinations that the productive quality of the lands is sufficient to give returns that will meet the estimated costs.

In making estimates of cost and of income, changing prices of materials used in construction and of products sold by the farmer must be given careful attention. In addition to determining the feasibility of irrigation projects and the working out of a sound land settlement policy, consideration should be given to the timing of irrigation development more nearly in accord with the demand for land by prospective settlers.

Progress of Irrigation

(Continued from Page 10)

River to the Goodwin Dam, jointly owned for several years by the irrigation districts. From this point it is allocated to the ditches and flumes for irrigation purposes.

San Antonio, Tex., Builds Flood Control Dam on Olmos Creek

(Continued from Page 17)

water contour and have a length of 1000 feet on the northeast and 600 feet on the southwest. They were planned and constructed to be fully as durable and attractive as their relation to a large dam would warrant. The roadway itself was built 30 feet wide for safety, and wherever feasible further protection was provided by building high parapets of native stone masonry.

Concrete was mixed at a central mixing plant having a 40-S tilting drum mixer with a capacity of 500 cubic yards daily. A stiff-leg derrick with a 100-foot boom, 20-foot bull wheel and a 1½-yard clam shell bucket, supplied aggregates from stock piles to bins of 240 yards total capacity over the mixer.

Concrete delivery was made by discharging batches into 1½-yard lock bottom-dump buckets which were loaded on industrial cars and pulled along a track behind the dam by 3½-ton gasoline locomotives. A traveling 5-ton stiff-leg having a 70-foot boom and mounted on two flat cars picked up the buckets and dumped the concrete between the forms. The rock-filled crib counterweight at the base of the rear stiff-leg (see photograph) was mounted on a flat car using a track parallel to that of the traveling crane. Concrete was thus poured in wood forms up to 18 feet from the crest. Blaw-Knox traveling forms were used in pouring the crest. This construction plant, which cost only $125,000, poured a total of over 90,000 cubic yards of concrete.

Wallace & Tiernan Win Suit

On July 6 the U. S. Circuit Court of Appeals in New York City affirmed without opinion the decision of Judge Bazel of the Western District Court of New York, rendered on January 29th, 1927, finding that the Village of LeRoy, N. Y., in installing a Paradon direct feed chlorine control apparatus had infringed U. S. Patent 1,007,647 issued to Carl R. Darnall.

This suit was brought by Wallace & Tiernan Co., Inc., owners of the Darnall Patent against the Village of LeRoy and Judge Hazel in his opinion made the Paradon Engineering Company parties defendant and found them guilty of contributory infringement.

"Western Waterworks" Begins on Page 25

WESTERN
Waterworks
Supplement to Modern Irrigation
Of Interest Expressly to Waterworks Executives, Contractors, and Municipal Engineers

Oakland Water Supply System from Mokelumne River Progressing as per Schedule

Contractors Making Completions Within Specified Time Limits; Project Will Be Finished Early in 1929

THE plans of the East Bay Municipal District, as early formulated and consistently followed, comprise the selection and construction of a water system to bring a large additional supply to the district, and to distribute this supply either by means of the existing system of pipes, properly enlarged and extended and connected with the new system, or by a substitute system built by the district.

The selection of the source was duly accomplished in 1924 by the approval of the report of the Board of Engineers recommending the Mokelumne Project, to provide for a storage reservoir above Lancha Plana, now called the Pardee Reservoir, and a pressure aqueduct from that point to the boundaries of the district. The choice was duly ratified by a vote of the people in November, 1924.

In November, 1924, a bond issue of $39,000,000 was authorized by the voters of the district for the purpose of acquiring the rights and constructing the Mokelumne Project to bring water to the district. The litigation which followed, resulted in the validation of the bond issue on September 23, 1925, the effective date of a decision of the Supreme Court of California. Immediately after this validation decree became effective, contracts which had been previously advertised, were awarded to Twohy Brothers Company and J. F. Shea Company for the portion of the aqueduct between Old River and San Pablo Creek, and work was started as soon as this could be done. Other contracts for the portion of the work east of Old River and the Pardee Dam were also signed with the same bidder with a defeasance clause, giving the district an option to order this work to proceed whenever the condition concerning the rights of way and water rights should, in the judgment of the board, warrant such action. The portion of the aqueduct from Old River to Pardee Tunnel was released under this proviso in November and December, 1926. The contract calls for completion on or before February, 1929. The Pardee Dam, and the Pardee Tunnel, serving as an outlet from the reservoir, have been held in abeyance pending the outcome of litigation over the lands which are necessary for the Pardee Reservoir.

The Lafayette Tunnel, extending from San Pablo Creek eastward about three miles was awarded to Smith Brothers, Inc., and is nearing completion. The Walnut Creek Tunnel, three and one-half miles further east, was completed in September, 1926, by T. E. Connolly.

Emergency Line Built First

The most urgent part of this work was the construction of an aqueduct between Old River and San Pablo Creek, in order that an emergency supply, if necessary, be pumped from Old River and discharged into San Pablo Creek; whence it would flow into San Pablo Reservoir and be available for use through present works of the East Bay Water Company. With view to its prompt completion, right of way acquisition was started upon this portion of the aqueduct as soon as funds were available therefor, and before the end of 1926, such rights were all acquired as far east as Old River. For the aqueduct proper, two condemnation suits have been found necessary, one of which was tried and settled, and the other is now pending, but occupancy of the land has been secured and the pipe has been laid across this tract.

Work was started in October, 1925, upon the urgent portion of the aqueduct between Old River and San Pablo Creek, and has been continuously pushed ever since.

Length of line from Old River to Walnut Creek Tunnel, 198,367 feet.
Amount of trench excavated for receiving this pipe, 171,049 do.
Pipe delivered on the ground, 175,257 do.
Pipe laid, 150,747 do.

The portion of the pipe aqueduct across the peat lands west of Old River is not to be buried, but is to be supported upon pile bents. For this purpose, 45,514 piles have been driven and 147 red wood bents erected. Between Walnut Creek pumping plant, and Walnut Creek Tunnel, a trench has been excavated for the entire distance and 4,045 feet of pipe have been delivered; 600 feet of this have been laid and joined. The portion of the aqueduct between Old River and Walnut Creek Tunnel was about 87 per cent completed at the

end of the year, and about 84 per cent of the contract time had elapsed as defined in the contract.

The Walnut Creek Tunnel was completed in September, 1926. In November, the Lafayette Tunnel had been excavated, and lining has been carried on ever since and at the end of the year about 50 per cent completed. As a whole, the contract was 78 per cent completed December 31, and 82 per cent of the contract time had elapsed. Between Walnut Creek and Lafayette Tunnels the aqueduct, in size to carry 200,000,000 gallons of water daily, is being built in circular shape, 9 feet in diameter, of reinforced concrete. The concrete work is finished, the backfilling nearly finished, and the work was in progress at the end of the year of the waterproofing and the construction of certain small auxiliary structures. The contract, as a whole, was 96 per cent completed on December 31, 1926. The spillway structure at the San Pablo terminus of the Lafayette Tunnel was practically completed at the same date.

On June 11, 1926, a contract was signed with Grier and Mead for the construction of the Claremont Tunnel, which is necessary to bring the mountain water within the boundaries of the district. This tunnel is about 3½ miles in length and its completion is required by the contract on January 16, 1929. On December 31, 1926, the contract was 12 per cent completed, and 21 per cent of the contract time had elapsed.

Litigation Retards Dam

In case the delay in the construction of the Pardee Dam and Tunnel is greatly protracted, it will be possible to install a temporary pumping plant near the town of Lancha Plana below the proposed reservoir, and to pump water directly into the aqueduct from the Mokelumne River. The time limit on the aqueduct contract indicates that this will be accomplished early in 1929, at which time the Claremont Tunnel is to be finished and delivery of water can begin, if a distribution system has been provided. It is not likely that the Pardee Dam can be built by that time to a height sufficient to divert water into the aqueduct.

It appears that the aqueduct from Old River to San Pablo Creek will be completed some time in May, 1927, and from Lancha Plana to Oakland about twenty months later, or January, 1929.

Lafayette Reservoir Planned

For the economical operation of the Mokelumne Aqueduct, it is necessary to have a reservoir near its western end at the proper elevation to serve as a balancing reservoir for this aqueduct and to supply the customers in case of a break in that aqueduct. For this purpose, plans have been made and the site acquired for a reservoir near Lafayette to connect with the aqueduct near that point between the Walnut Creek and Lafayette tunnels. The outlet of this reservoir will be about the same elevation as that of the aqueduct and it will be necessary to fill it by pumping. For this purpose, a pumping plant will be established on the aqueduct at the point of connection and at the same point a screening chamber and aeration weir are provided to screen the water before it enters the Lafayette Tunnel.

When the Lafayeete Reservoir is full, it will hold about 4,000,000,000 gallons of water, which is equivalent to over four months' supply for the district at the present rate of consumption. This will normally be kept practically full and will serve to supply the district, in case of a break in the aqueduct or interruption of service from any other cause.

In case it be found necessary, a temporary pumping plant will be installed on the bank of Old River in the spring of 1927, in order to provide an emergency supply of water from that river through the aqueduct and discharge the same into San Pablo Creek. A pump for this temporary plant will be the same as provided for the Walnut Creek pumping station and will be one of the three units of that station. Another pump will be placed at Walnut Creek and by working both these pumps to full capacity, a daily supply of about 30,000,000 gallons can be delivered into San Pablo Creek, but it will not be decided whether or not to install this temporary plant until about the end of March when knowledge will be available concerning the run off from local water sheds.

Distribution System

In attempting to adapt the local distribution system of pipes now operated by the East Bay Water Company to the delivery of water from the Mokelumne Project, we are faced with a complicated situation, due to the heterogeneous nature of the local system. This system was originated by a number of small companies which organized to supply each a small area and, in some cases, to compete with each other. None of them planned a system for serving the great metropolis as it now exists, and, in some cases, duplication of delivery resulted.

The consolidation of these companies and the adaptation of their systems to more comprehensive service produced some improvement, but even the larger plans were based upon the production of water at Lake Chabot and at the two large well groups of Alameda and Roberts Landing. Thus the main water supply was south of the district and the great mains from that direction, proceeding north, gradually branched out to serve their customers. A supply brought from the north, therefore, through the Claremont Tunnel meets the small ends of these pipes inadapted to receive a large supply and deliver it to the heart of the system. For this reason, any method of economical distribution of the mountain water supply demands the construction of large transmission mains to deliver water to various points in the district, and carry it to the existing trunk lines, from which it can be distributed to the consumers through existing pipes. Three large transmission mains have been planned, and will be necessary whether the present distribution system is utilized or a new one built.

A small reservoir, called the Rockridge, will be constructed on the south side of Temescal Canyon, which will connect with the Claremont Tunnel. Contract for the pipe line connecting this future reservoir with Claremont Tunnel has recently been let.

Route of Transmission Lines

From the Rockridge Reservoir, a large main transmission pipe line, varying in size from 56 inches to 40 inches in diameter, extending ten miles southeastward, has been planned and the route has been selected. A portion of the right of way has been purchased and suit has been brought for the acquisition of the reservoir on the Old Durant Estate near the Sequoia Country Club, and called the Sequoia Reservoir. This name Sequoia, has also been given to the aqueduct connecting it with the Rockridge Reservoir.

Surveys have also been made and plans are in progress for constructing a similar large aqueduct to the northwest from the Claremont Tunnel, which will pass south of the Campus of the University of California and convey water to a small reservoir near the boundary of Richmond. Another large main will follow down Shafter Avenue, Clifton Street and Ffty-sixth Street to connect with the large pipes on San Pablo Avenue and Webster Streets.

Extracts from the annual report of the East Bay Municipal Utility District for the year 1926. The August issue of Modern Irrigation will carry a detailed description of the construction features of the project.

Fred A. Rhodes, formerly city manager of San Diego, is now superintendent with the firm of Bert Noble, general contractor of San Diego.

Anacortes (Wash.) Municipal Water System Becomes Model for City of Its Size

System Was Purchased from Washington Power, Light & Water Company in 1919; Utility Bond Issue of $150,000 Pays for Improvements

By W. B. SHORT
City Engineer, Anacortes, Wash.

THE city water system was purchased from the Washington Power, Light & Water Company in 1919. The purchase was made from the proceeds of a $150,000 bond issue voted by the citizens. Of this issue $60,000 was a utility bond and $90,000 a general obligation bond. Although the $90,000 is general obligation, the water department has paid from the revenues $20,250 interest on the $90,000, and $19,440 interest on the $60,000, also retiring $44,000, principal of the $60,000 (the principal of the $90,000 not yet being due), making a total paid in interest and principal from the revenues of $83,690.

At the time of the purchase there were 945 services, with an average monthly revenue of $2,400. On this date there are 1,426 services, with an average monthly revenue of $3,825. There has been added to the system from the revenue fund 10,000 feet of main, 200 meters, 481 services, and the distribution system thoroughly repaired.

Single Source of Supply

At the time of purchase, the only source of supply was Heart Lake and Whistle Lake, these lakes being supplied from the run-off of the watershed during the wet season. As the lakes were being drawn down their limit each season and the consumption gradually increasing, it soon became apparent that the city would have to augment its supply.

A careful survey was, therefore, made of all available sources of supply on the island. This survey and investigation extended over a period of two years. Careful measurements of the areas and depths of the lakes were made, together with the areas and run-off from the watershed into the lakes. After these data were assembled and checked, it was decided that the most practicable and economical thing to do was to utilize the waters of Lake Erie and Lake Campbell, together with Whistle Lake, thus temporarily discontinuing the use of Heart Lake.

Improvements Listed

Plans were then prepared for the following improvements:

A 1200 G. P. M. pumping unit at Lake Campbell.

A 14-inch pipe line from Campbell to Whistle Lake.

A 1500 G. P. M. pump at Whistle Lake.

A 2,000,000 gallon filter.

A 12-inch pipe line from the filter to the reservoirs.

A 1¾ million gallon reinforced concrete reservoir, and

1 16-inch main from the reservoir to the distribution system.

For the purpose of the above installation the citizens of Anacortes voted a $150,000 utility bond issue. This issue is strictly an obligation of the water department and cannot be paid from any source other than the revenues of the department.

Construction on the new installation was begun October 14, 1924, and finished December, 1925, more thoroughly described below.

Pumping Facilities

The pump at Lake Campbell is a three-stage DeLaval pump, directly connected to a 150-horsepower Fairbanks-Morse motor. This pump is housed in a concrete building, 17.5x31.5 feet, large enough to permit the installation of a second unit, should conditions require.

The water reaches the pump by means of a 20-inch pipe line extended from the pump house to a point 265 feet out in the lake. The outer end of this pipe is enclosed in a pyramid tower surrounded by a one-quarter inch screen. The water passing through the pipe line reaches the sump and again passes through screens before reaching the pump. This intake pipe line lies in a horizontal position, being partly in excavation and part of it resting on piles. It was built with sufficient capacity to accommodate two pumping units. The pump runs continuously and without an attendant. It is visited and inspected once a week.

The water leaving the Campbell lake pump passes through 2,100 feet of 14-inch steel pipe and 3,000 feet of 14-inch creosoted wooden pipe, and is delivered into Whistle lake on the south side.

Operation by Remote Control

The Whistle lake pumping unit consists of a single stage DeLaval pump, directly connected to a 30-horsepower Fairbanks-Morse motor, housed in a 10 x12 foot concrete building, and is so located that when the lake reaches its maximum height the pump house floor will be six feet below the water elevation. This pump will lift the water from 20 to 29 feet (the height being variable as the elevation of the water in the lake varies), the high point being 360 feet distant from the pump house. From this point the water flows by gravity through a 10-inch pipe to the filter. The Whistle lake pump will also run without an attendant, being operated by remote control from the filter.

As the water enters the filter the chemicals are inserted by means of a small electric-driven pump. It then runs through the aerators into the settling basin, where it remains a few hours, giving the suspended matter an opportunity to settle to the bottom. The water then is drawn off and passing into the clear water well, is chlorinated before passing through 6,000 feet of 12-inch pipe to the reservoirs on the Heart lake road.

Reservoir Construction

The new reservoir is of reinforced concrete construction, 140x180 feet, 14 feet deep, having a capacity of 1,750,000 gallons. The old reservoir, which is circular and of concrete construction, has a capacity of 400,000 gallons. The two are of the same depth and elevation. Both are supplied from the same pipe line from the filter and both discharge into the same pipe line leading to the city, but these pipe lines are so arranged that each reservoir can be operated independently and separate from the other. There is an altitude valve at the reservoir which records on a chart at the filter the depth of water in the reservoirs at all times, and by means of electrical control the filter operator opens or closes the intake valve at the reservoir, as the conditions may require.

The entire installation is so arranged that the man at the filter will operate all units from the time the water leaves Campbell lake until it is filtered and in the reservoir.

Samples of the filtered water are sent to the State Board of Health monthly for analysis, and occasionally the state sanitary engineeer visits the plant.

Basic Study of Sewage Treatment Indicates Fundamentals of the Various Processes

By E. B. BESSELIEVRE
Sanitary Engineering Division, Dorr Company

THE general forms of sewage treatment employed, which are all subject to modification depending upon local requirements, are as follows:

1. Dilution with or without chlorination.
2. Coarse and fine screening, with or without chlorination.
3. Sedimentation.
   (*a*) Sedimentation preceded by fine screening and followed by chlorination.
   (*b*) Sedimentation followed by chlorination.
4. Oxidation.
   (*a*) No. 2 or No. 3 followed by 1. Sand Beds; 2. Contact Filters; 3. Trickling Filters; or 4. Activated Sludge.
   (*b*) No. 2 or No. 3 followed by one of the above, with chlorination of the effluent.
   (*c*) Fine screening with activated sludge, followed by sedimentation and digestion of activated sludge.
   (*d*) Preliminary sedimentation followed by activated sludge, sedimentation and digestion of the combined sludges from preliminary and final sedimentation tanks. This is being carried out at Ft. Lauderdale, Florida, and at Chicago, Illinois.

Dilution Without Treatment

This consists in the discharge of the untreated sewage into a larger volume of water that contains sufficient dissolved oxygen to oxidize the organic matter in the sewage and prevent odors. The cities, especially those located on inland waters, and even those located near the coast, which may use this method without creating a nuisance in some form, are rare and are becoming more so each year.

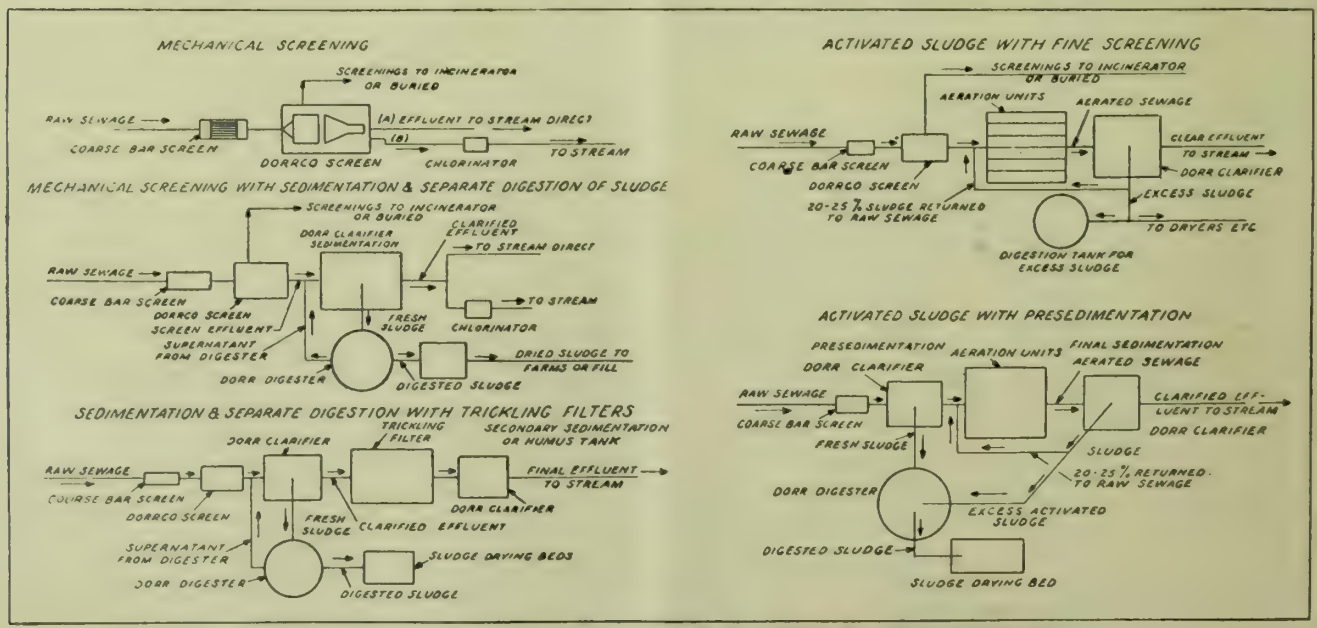
Removal of Coarse Solids

Where the problem is one of protection of bathing beaches from floating, unsightly solids, or the elimination of masses of floating solids, the most economical and most generally employed method of treatment is screening. The equipment used for this treatment may consist of fixed screens made of bars or rods, which are cleaned by hand or mechanically, or it may consist of mechanically operated fine screens which are self cleaning. Generally, both bar and fine screens are used.

The mechanically operated fine screen, usually provided with slots 1/16 of an inch by 2 inches in length, removes all of the solids that are larger than 1/16 of an inch in size, which means practically everything visible to the average person. The material that is removed, resembling garbage in appearance, amounts to about 25 to 30 cubic feet per million gallons of sewage and may be readily disposed of by incineration. A fine screen will ordinarily remove 10 to 15 per cent of the total suspended solids.

Where a removal of more than the coarse solids is required, and when as many of the solids as possible must be removed, sedimentation is usually employed. Part of the solids in sewage is fine, too fine to be caught by a screen even with 1/16 or 3/64 of an inch openings, but such solids will either settle or float if the velocity of flow is sufficiently reduced so that the solids are not carried along. A sedimentation tank, which is simply an enlargement of the sewer to the extent that the velocity of flow through it is too low to transport these fine solids, is used to remove them and is usually placed at the outfall. A velocity of 2.5 feet per second in a sewer will carry along practically all of the solids; and a velocity of 1 foot per second will carry along the organic solids but will drop out the sand and the grit. A velocity of less than ½ foot per second will usually drop out most of the lighter solids.

The sedimentation unit is usually a square, fairly shallow, tank. The sewage enters one side and flows across the tank



FLOW DIAGRAMS OF FIVE TYPES OF TREATMENT AS SHOWN BY THE DORR COMPANY IN THEIR SANITARY ENGINEERING BULLETIN.

and out of the opposite side, allowing the fine solids to settle during the passage across the tank. The tank is usually equipped with a mechanism which continuously collects the solids that have settled to the bottom, and known as sludge, and removes them from the tank. This type of tank will ordinarily remove from 60 to 75 per cent of the suspended solids and from 90 to 95 per cent of the settlable solids. The effluent from such a tank is usually clear and contains no solids visible to the eye.

As the solids removed from a sedimentation unit are fresh and must undergo decomposition, they are not available for spreading on land until they have been treated further. This treatment is usually done in tanks known as digestion tanks where the organic solids are acted upon by bacteria which function in the absence of air and which are known as anaerobes. These bacteria change the organic matter into gas, liquid, and inert material, and the resultant sludge amounts to about 43 per cent of the original material and may be discharged directly upon sand beds and dried in the sun without offense. The volume of sludge from a sedimentation unit as described will average about 2,000 gallons of 90 to 92 per cent moisture sludge, per million gallons of sewage.

Oxidation of Organic Matter

As the discharge of sewage into a stream, even after screening and sedimentation have been employed, may still produce trouble, this step of treatment is frequently required. The time when trouble begins, or when danger is shown in a stream, is when all the dissolved oxygen normally in fresh water has been absorbed. Fish require a minimum of 3 parts per million dissolved oxygen to persuade them to inhabit a stream.

The discharge of unoxidized sewage into a stream absorbs the oxygen from the water until the organic solids have been oxidized and thus may draw the available oxygen down to a point where none is left. This will cause fish to die and will also bring odors, as the unoxidized sewage will continue to decompose and the river will become, virtually, a large septic tank. Examples of this have been the Passaic River in New Jersey, the Chicago Drainage Canal in Illinois, and the Hudson River in New York, and many others. Therefore, in cities located on streams which are small or which are used for human purposes, it is usually necessary to oxidize the organic matter remaining in the sewage after sedimentation. This result may be accomplished by several methods and the selection of any one of them is usually a matter of judgment of the engineer taking into account all of the influencing factors.

The methods that have been generally used for oxidizing sewage, in the order of their development, are as follows:

1. Sand Filters.
2. Contact Beds.
3. Trickling (sprinkling) Filters.
4. Activated Sludge.

The sand filter, which was the earliest method used and which is still used to some extent for small communities in New England, consists of a bed of sand, two to three feet deep, upon which the sewage is allowed to flow. The sand retains practically all of the remaining solids and the bacterial life, surrounding the sand grains, destroys and stabilizes the organic matter. The disadvantages of this method are the enormous areas required, the frequent cleaning of beds due to clogging, and the breeding of flies.

Contact Filter

The contact filter which was the next development consists of a concrete tank filled with five to six feet of broken stone. Sewage is allowed to flow into these tanks, between the stones, and usually remains for a period of two hours. During this period, the bacteria covering the stones destroy and oxidize the organic matter both in suspension and in solution. When the sewage is discharged at the end of the period, the action of the sewage in passing downward draws air into the interstices of the filter material and revivifies the bacteria. Such bacteria are known as aerobes and require a supply of oxygen for their existence. A contact filter requires less area than a sand filter but it is more costly to build per unit of area and requires cleaning about once every two years; however, it can oxidize a larger quantity of sewage per unit of area than the sand filter.

Trickling Filter

The next advance was the trickling filter, first known as the sprinkling filter, which consists of a bed of broken stone from six to ten feet deep. The sewage is distributed to all parts of the surface of the bed, in a thin film, through a series of spray nozzles, thus taking up some oxygen from the air. As the sewage trickles down through the bed, the aerobic bacteria on the surface of the stones oxidize the organic matter. This unit, in turn, requires less area than the contact filter, but owing to its distribution pipes and complicated underdrain system it is also more expensive. However, it will handle a larger volume of sewage per unit of area than either the contact filter or the sand filter.

Another feature of a trickling filter is the discharge of the accumulated residue of the digestive work of its bacterial inhabitants, occuring usually twice a year, but sometimes more frequently and unless a settling tank is placed after it to receive this residue, the effluent may be worse than the influent.

The latest and the most important development in processes for the production of a completely oxidized and stable effluent is the activated sludge process. This process consists of passing the sewage through tanks of such size to permit a detention of from four to six hours, while at the same time the sewage is kept in continuous agitation either by compressed air or by mechanical means, and a proportion of the sludge, highly active bacterially, is mixed and passed through with the sewage. This action produces a flocculating effect so that when the aerated sewage flows into a sedimentation unit, the flocculated solids settle out, carrying down the colloidal and the dissolved organic solids. A portion of the settled solids is returned and mixed with the sewage in the aeration tanks. This process has been aptly described as "passing the filter through the sewage instead of the sewage through the filter."

Produces Clear Effluent

When properly operated, this process, like the others described, produces a clear effluent, usually as good as, and often better than, the stream into which it is discharged. The effluent will usually be non-putrescible and stable, that is, it will not putrefy or create a nuisance, and when tested by the methylene blue method it will not discolor the solution in twenty days.

This process does produce, however, a very wet, voluminous sludge, potentially high in nitrogen (5 to 7%) and, therefore, it has value as a fertilizer. Attempts to produce a commercial fertilizer have been tried (Milwaukee, Wis.), but they have been so costly that most cities which adopt the activated sludge process do so for its effectiveness and do not attempt to recover the sludge as a fertilizer.

To give an idea of the relative size required for plants to give complete treatment, based upon the different methods described, the following table is given. This is based upon a plant having a capacity of ten million gallons per 24 hours, equivalent to the flow from an average city of 100,000 population.

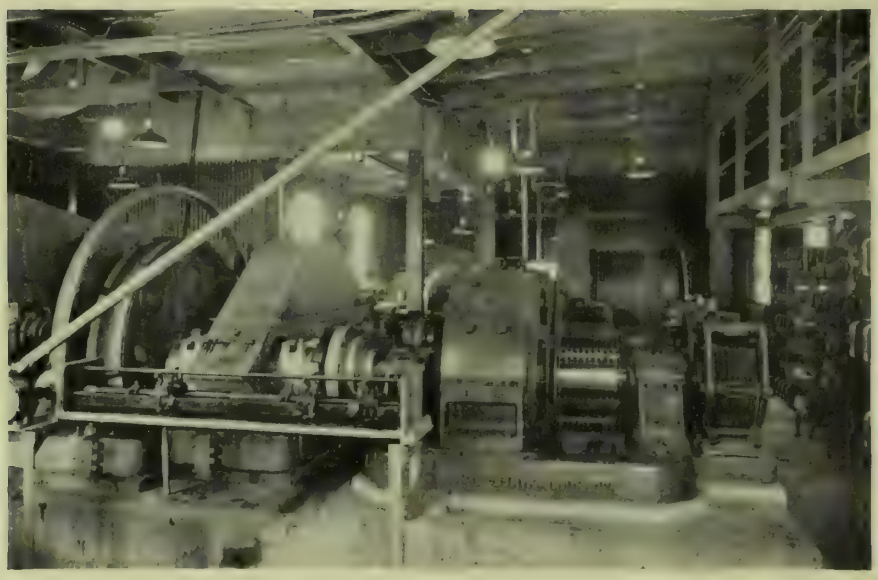
Comparative Costs of Treatment Works Capacity—10 M.G.D. per 24 hrs.

Type	Acres Required	Approx. First Cost of Plant	Approx. Operating Cost M.G.
Sand Filters	100	$1,500,000.00	$2.-$4.
Contact Beds	20	800,000.00	4.- 6.
Trickling Filters	4.0	200,000.00	2.-10.
Activated Sludge	1.0	500,000.00	21.-24.

Sterilization

Because none of the steps attempts to destroy, completely, all of the germs which produce intestinal or other disturbances, many health authorities con-

(Continued on Page 40)



The side view of a "Cradle Hoist" drive, showing LS-411 Limit switch with differential connection to "Girder Screw." Such application of the electric drive to general hoisting machinery is finding wide application by contractors engaged in heavy concrete construction work in the irrigation and waterworks fields.

How Pumping Equipment Has Kept Pace with Increasing Water Demands

By A. W. BAKER*

WATER, one of the essentials of life, is required to perform three important and necessary functions in every municipality; first, water for the general use of the people; that is, drinking, cooking, bathing, etc.; second: for sewage disposal and third: for fire protection. As far back as history records, the question of an adequate supply of water for municipalities has presented an extremely important problem. In the days of the Roman Empire, the Caesars directed their engineers to build the famous Aqueduct, part of which survives to this day, to bring water by gravity from the hills outside the city to Rome.

During the past two thousand years, other towns and cities that had available a water supply at a sufficient elevation, have copied the old Roman system and installed aqueducts to provide water supply by gravity. An example of this in our district in modern times is Greenville, South Carolina, where until a few years ago, the entire city was supplied from Paris Mountain (a few miles from the city) in this manner.

As the population of the world has grown and civilization increased, the number and size of municipalities has increased with their ever increasing demand for water.

*A paper presented at the Southeastern Water & Light Association Convention in Jackson Miss. Mr. Baker is in the Atlanta, Ga., office of the General Electric Co.

It is surprising how the more comfortable mode of living of today has brought a marked increase in the demand for water. In the past few years, in the smaller cities, the average demand has increased from 30 to 80 gallons per capita. In the larger cities, even where meters are used, the demand has increased from 100 to 150 gallons per capita. There are better homes being built, more bath tubes installed, more lawns and flowers being watered, etc., which means that more attention must be paid to the supply system in order to meet the increased demands.

It was not until in the past century, after the invention, design and development of reiprocating engines and pumps, that water was supplied to municipalities by power driven machinery. This development made rapid progress in the last half of the nineteenth century and the early part of the twentieth century. Large reciprocating pumps of the crank and fly wheel design became so efficient that the best performance for such units would give two hundred million foot pounds per thousand pounds of steam. On the other hand, these units were extremely large, expensive in first cost, required a large number of operators and their many valves and reciprocating parts had naturally a high maintenance cost.

Wide Use of Centrifugals

With the advent of electricity, pumping engineers and electrical manufacturers addressed themselves to the problem of handling liquids of all kinds by centrifugal pumps, with the result that today, pumps are equipped with squirrel cage induction motors, wound rotor induction motors, synchronous motors, direct connected steam turbines and steam turbines geared to the pumping unit. The efficiency and economy obtained, taking all factors into consideration, has brought about their extensive adoption. As compared with steam driven, vertical triple expansion pumping units for municipal work, the motor driven outfit occupies less room and results in greatly reduced expenditure for maintenance and supervision.

Where water is supplied to reservoirs or storage tanks, the operation of motor driven pumps may be rendered entirely automatic by the use of float or pressure switches, which can be adjusted to start and stop the motor promptly when variations in the water lovel occur and thereby tend to maintain water storage at any required volume. Where current is purchased from central stations, it is frequently feasible to arrange pumping periods so that the maximum demand for current will occur during off peak periods which in turn, makes feasible the quoting of low rates for current.

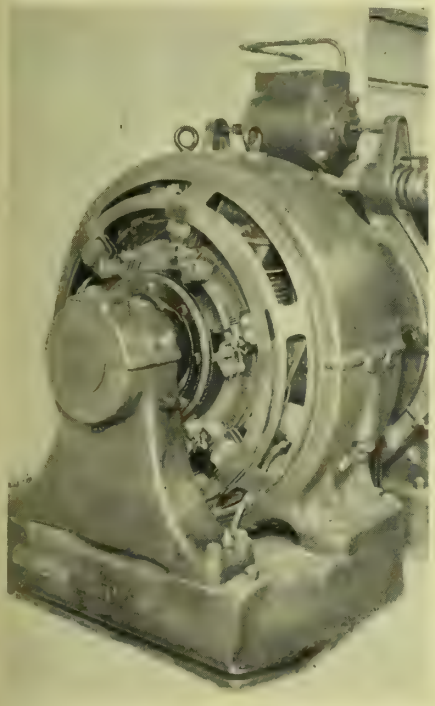
Use in Sewage Plants

In sewerage disposal plants, centrifugal pumps are generally used, as their construction enables them successfully to handle liquids containing a large percentage of solid matter in suspension. The operating conditions of sewerage disposal pumps usually comprise low head and relatively large volume. A typical example in this district is the synchronous motor driven disposal pumps in the city of New Orleans, Louisiana. In fact, the pumping situation in the city of New Orleans is unique as the city normally lies below the level of the Mississippi River, which requires three departments of pumping for the municipality; one for general use of water through filtration plant, one for drainage system and one for sewerage disposal system. All of this water has to be pumped from the lower level of the city back into the river. Where central station power is not available and local conditions do not permit electric drive, turbine driven pumps in general, make the most economical method of handling water.

For a long time, manufacturers were confronted with the problem of adapting steam turbines to centrifugal pumps, trying to develop a unit that would be cheap in first cost, and comparable in efficiency, with a high efficiency reciprocating engine. The change in steam conditions of the past few years, such

as higher pressures, higher superheat and higher vacuum, has made it possible to use a reduction gear between the turbine and the pump, which makes a very satisfactory arrangement.

At first the duty obtained from such an arrangement was not so good as the duty obtained from the engine units, but the low first cost of the units plus a reduction in building and foundation costs, which means a large saving in fixed charges, plus a saving in operating and maintenance expense, has made it profitable to install turbine centrifugal



The commutator end of a traction motor. This type of installation is fairly common on elevators of all classes. Heavy duty motors are being used quite extensively in the West for driving water pumps, sewage disposal pumps, filtration plant pumps, and general irrigation pumps. They have been found to be economical and reliable, and have a surprising overload capacity.

pumps. Today it is entirely possible to build a turbine driven pumping unit, with a guaranteed duty equal to, and in many instances greater than that of the most efficient engine units.

Turbine Costs

We might take as an example the original cost of a reciprocating pumping engine including condensers, piping, boilers, tools and supplies as $147,000. The turbine unit costs $58,000.00, but due to the difference in fixed charges, the turbine would operate for approximately $6,000.00 cheaper than the crank and fly wheel set. There are notable examples of this turbine pump type of unit in Baltimore, Memphis, Nashville, Omaha and Philadelphia and mostly in units from 1,200 to 3,000 H. P.

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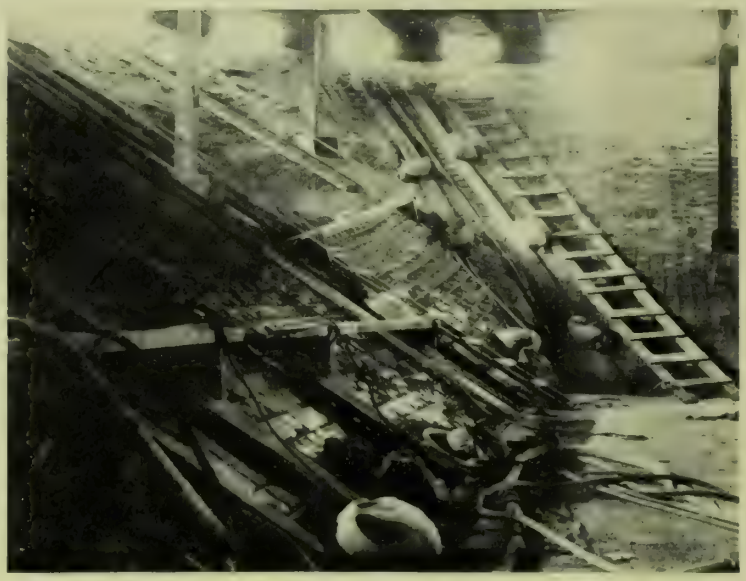

Modern Reservoir Engineering—with *Aquatite*

THE ABOVE kodak picture was taken on the reconstruction work of the Garfield Avenue Reservoir at South Pasadena, Calif. Olmstead & Gillelen, designing engineers, figured that a portion of the old pavement could be made ***safe*** with a double membrane. This membrane consisted of the laying horizontally of 10 oz. fabric, run through an Aquatite bath, then laid vertically, lapping all edges, and freeing the expansion joints, so they could be treated individually.

After the fabrics were tightly bonded on to the old concrete with Aquatite and hot Conwax, re-inforcement and Guniting were used to complete it. One of the FINEST membrane systems ever applied anywhere on a concrete reservoir—a membrane 100% tightly bonded. If you are not already familiar with the balance of the re-construction, we will advise how it was done.

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WRITE FOR CATALOGUE

Some of the most interesting and practical engineering studies are presented by municipal pumping enterprises. Steam direct, steam-electric, oil engine, electric or purchased power for electric drive all have to be considered and settled after carefully weighing all the complex conditions that bear upon the answer.

Where central station power is available, the large generating station has a great advantage as 1½ to 2 pounds of good coal will generate 1 K. W. H. whereas the small station will require 3 to 6 pounds of coal per K. W. H., and much greater operating cost per K. W. H. as well. It is apparent that except in the very largest cities, the cost of municipalities making their own current, will be much higher than purchased power. An argument used at one time, which had much weight, referred to the reliability of the municipality owning the station or at least the desirability of a private plant as a stand by in case of failure of the public supply. This argument has less and less force as the years have gone on. Reserve units in the central station, interconnection with other hydro and steam stations and adequate lighting protection have all worked to make even a momentary "out" a very unusual occurrence. Today "power off" is far less likely to occur on a power system than on even the most carefully supervised small plant.

Costs Compared

Among the prominent synchronous motor installations are those at New Orleans, Louisiana, Albany, New York, Duluth, St. Paul and Lansing. Wheeling, West Virginia, has 700, 900 and 1,300 H. P. units of the wound rotor, induction motor design in successful operation. The city of Detroit has one of the most efficient pumping units that we know of where the overall efficiency "wire to water" is 84% on a 70,000,000 gallon centrifugal pump driven by 2,600 H. P. synchronous motor.

Some comparisons of operating costs of various types of drives as compiled by consulting engineers and others may be of interest.

Filtration plant pumps at Albany, New York, were changed from steam to electric drive on purchased power with a saving of $30,000.00 per year for the past six years.

The cost of pumping per million gallons at Savannah, Georgia, was cut from $65,000 for the steam system to $10,00 for the electric system.

Annual operation and repair costs on a 24,000,000 gallon electric station in Chicago are $3,000.00 as against $16,-

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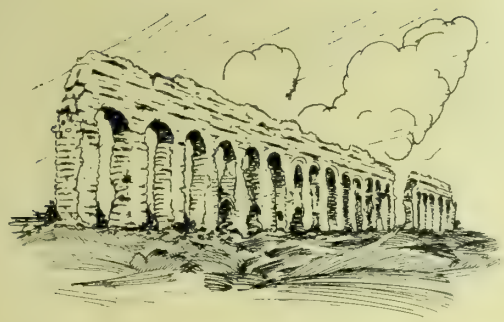

Pure Water

"Among the blessings conferred upon the city by the bounty of the gods is the water of Marcia: the clearest of all the waters in the world and distinguished for coolness and salubrity."
—*Pliny.*

In these days of widely diffused scientific knowledge, practically every enlightened community however remote is interested in a supply of pure water. The four main sources of water,—rivers, lakes, wells and springs, are never free from suspended or dissolved foreign matter. Water may be entirely free from disease producing bacteria, yet be so highly colored or turbid as to render it unfit for drinking purposes, or useless to certain types of industry.

A water may be satisfactory today, but what assurance is there that tomorrow the same supply will not become dangerously contaminated? "Protected" water-sheds, since the advent of the automobile with its loads of picnickers, cannot be adequately patrolled. Industry will not settle in a community where the public water supply is muddy, colored or filled with foreign debris.

Water purification as developed by modern sanitary science will remove all suspended matter, color, taste, odor and hardness. It will provide water that is inviting, pleasing in appearance and safe for drinking and domestic use.

This is one of a series of "advertorials" cooperatively designed to broadcast a more general knowledge of the relation between public water supply and community health.

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STORAGE & DISTRIBUTION

What One State Is Doing to Eliminate the Hazard from Cross Connections

By WARREN J. SCOTT, S. B.

THE question of cross connections between potable water supplies and impure supplies is one that has been causing increasing concern to health authorities and waterworks men. The principal reason is the mounting number of deaths and cases of sickness from cross connections. The Committee of Cross Connections of the Conference of State Sanitary Engineers compiled a list of epidemics of typhoid or other waterborne diseases, attributed to cross connections. Many figures were unavailable but those obtained showed a total of 123 deaths, 1,664 cases of typhoid fever and 3,155 cases of other intestinal disorders, brought about by cross connections. These cross connections were piped connections between polluted and potable supplies, separated by gate valves, check valves or other means. Gate valves may leak or may be opened inadvertently. Check valves are mechanical devices for allowing the flow of water in only one direction. Many of them have been found to leak very badly, in some cases with the clapper suspended so as not to function at all. Differences in pressure have been depended upon to serve the same purpose as check valves but breaks in mains or other happenings with resultant drop in pressure on the high pressure side have been productive of disaster.

Arrangements whereby polluted water was pumped into public supply mains by auxiliary intakes or by-passes used at times of shortage or other emergency, account for a total of 103 deaths, 5,088 cases of typhoid fever and about 8,000 cases of other intestinal disorders, according to figures that are available. Many figures in addition are missing.

Another fact which has been borne home to waterworks officials is the tendency of the courts in recent damage suits to place increasing responsibility upon the waterworks owners to eliminate dangerous cross connections.

In general, the kinds of cross connections which exist come under five different classifications: (a) fire service, (b) industrial use, (c) boiler feed, (d) pump priming, (e) auxiliary drinking water. One reason for cross connections is to have two supplies available, as on a fire service line, so that in case of the failure of the public supply or a fire pump drawing possibly from a polluted source, the other source would be ready for use. Another reason might be to save the expense of city water where large volumes of water are needed for industrial purposes, and it is desired to have city water available for emergency. Where water is used for cooling purposes, the city supply from a surface source may be at too high a temperature in the summer, necessitating the use of water from a private well. These two supplies are, therefore, piped together at the cooling plant. Many persons have a private well or spring which they pipe to the house and prefer to use for drinking purposes instead of the city supply. They wish, however, to have the city water ready for use if needed, so that both the city supply and the private supply are piped together in the cellar of the house. Such private supplies must be inspected and analyzed before the interconnection can be approved.

New Regulations

In consideration of the danger to the health of Connecticut's citizens, the Public Health Council of the State Department of Health has adopted cross connection regulations as a part of the Sanitary Code of the state. Before the passage of these regulations, two public hearings were held at which waterworks officials, manufacturers and insurance interests were invited to appear and present their views. These hearings resulted in a frank exchange of views and were of immense value. The manufacturers and insurance interests established their desire to cooperate in removing a health menace. Connecticut is a manufacturing state with many leading industrial centers. The problem was a real one and Connecticut's manufacturers should be strongly commended for the manner in which they have put their shoulders to the wheel.

The regulations as adopted provide that after December 31, 1926, no cross connections shall exist between potable and non-potable water supplies, except that installations protected by double check valves of approved type, with adequate facilities for testing, which were in existence on December 31st, may be temporarily permitted with the approval of the State Department of Health. The latter provision was inserted because it was felt that double check valves of the latest improved type should be given a fair try-out. The length of the extension of time granted will depend on the investigations which the department is now making as to the efficiency of the newest types of check valves.

Valves Under Surveillance

The Connecticut State Department of Health has not recommended double check valve installations. It has strongly recommended absolute separation of auxiliary supplies. In some cases, manufacturers have advised us that either because they felt the newest check valves would be satisfactory or for financial reasons, they would temporarily depend on double check valves of approved type. They have been told that the check valves may be ordered out at any time if pending investigations prove their inefficiency. For temporary use, the Department has approved the special Factory Mutual check valves and the new Rice valve. The latter is an all bronze valve designed with ample clearance and a round rubber facing which is supposed to produce a hair-line contact between the facing and the seat, so as to close over small particles of grit. Temporary permits have been issued to the owners of double check valve installations, copies of the permits being sent to the water officials in charge. All installations must be provided with water-tight pits, self-indicating gate valves, drip cocks and gages for testing. They will be inspected periodically by the State Department of Health and waterworks officials, for it is well known that whatever measure of success is obtained with double check valves depends largely on inspection and maintenance.

The Work of Elimination

A great majority of cross connections have been eliminated. Hartford and Stamford had already effected complete separation by their own efforts. The results in such cities as New Britain with no cross connections left, Bristol with all eliminated but one double check valve installation, and New Haven with only two, point to the excellent progress made in but a few months of earnest work. Some cities still have a considerable number of double check valves, either in existence previous to the passage of the regulations or since installed, but even here we have a markedly less hazard than with the old neglected connections.

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In many cases, separate piping has been provided for polluted water; others have installed tanks filled with city water; city water to large tanks supplied by two sources has been made to discharge above water level; priming connections have been replaced by small tanks filled from above with city water; for boiler feed or other industrial use, swing joints with an elbow and unions have been used in the case of small diameter piping whereby either of two supplies can be used but both can not be used at once. These represent some of the methods used to bring about complete separation. In many plants, it has been surprisingly easy. Others have been more complicated. As one waterworks official has expressed it, some piping systems have been found to be literally "sewed together" and much time and effort has been needed to separate them.

The regulations provide against interconnection with the public supply unless the auxiliary supply is approved by the State Department of Health. The inspection and analysis of many private supplies has been carried out as a result of requests for approval. Some supplies have been approved, others have been improved and later approved, and still others have been condemned. In this connection, many water supplies of doubtful quality have been brought to light and condemned for drinking purposes.

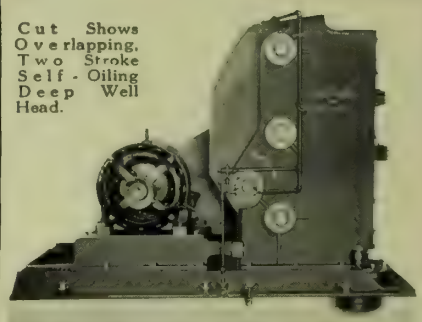
Results Accomplished

It is felt that the method of procedure carried out in Connecticut has been very satisfactory. It has produced splendid results and has met with excellent cooperation.

Certainly with the precautions which are being taken to protect our watersheds and treat our supplies and with the existing safeguards which nature has provided by storage and dilution, there is no direct menace comparable to pumping a "slug" of polluted water into the mains which supply people for drinking. It is unquestionably a very real and not a fancied danger and has probably caused many isolated cases of sickness or death in our own state, even though not recognized as the factor.

Water Companies Merge

The South San Francisco Water Company has been merged with the Peninsula Water Company, operating in San Mateo, California, which in turn is to become an integral part of a larger system to be known as the Pacific Water Company, a new corporation. While the sale price of the South San Francisco Company has not been announced, it is known to exceed half a million dollars.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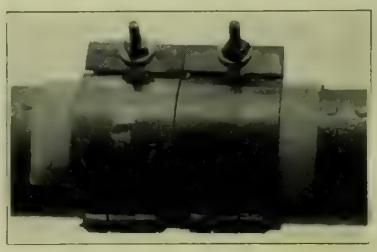

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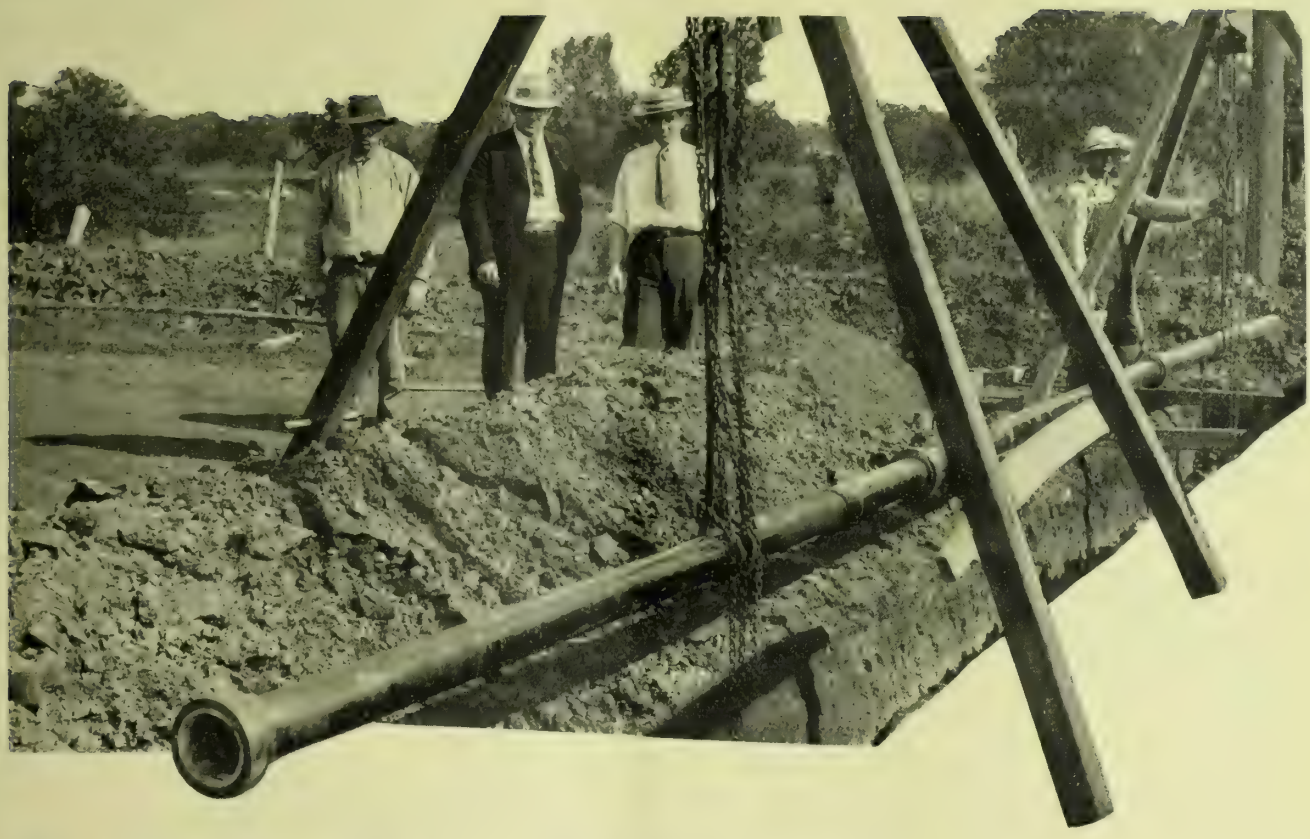

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> ". . . Anyone who acquaints himself with its many advantages will never consider going back to the old style pipe."

McWane sizes are 1¼ through 8 inches, the lengths standard, and even the Fittings have Precalked Joints.

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WATER PURIFICATION

Big Decrease in Typhoid Death Rate Due to Filtration and Chlorination

IT is well known that during the past twenty years, typhoid fever as a cause of death has sharply declined, until today it has become a very minor element in the general mortality record of American cities. Although this achievement can be attributed, in part, to the adoption of such means as pasteurization of the milk supply, the installation of proper sewage disposal, and the regulation of food handlers with a view to controlling the hazard of infection from typhoid carriers, the chief factor in the suppression of the disease in cities has undoubtedly been the purification of water supplies.

In a forthcoming monograph bearing upon the control of typhoid fever, the Metropolitan Life Insurance Company will review the history of the incidence of the disease, and will describe the successful measures that have been adopted to suppress it in American states and cities since 1860. Detailed accounts of typhoid mortality in each of a number of the large municipalities of the country will be presented in which many interesting facts regarding the disease will appear, particularly the part played by pure water in the reduction of the typhoid death rate. Obviously, in this article, these individual histories for cities above 250,000 of population cannot be given. The complete monograph will present discussion of the facts on typhoid control in each of these larger cities. For cities under 250,000 of population there can be shown the influence that improved water supplies have had upon the typhoid fever death rate. These smaller cities have been grouped in three size classes—25,000 to 49,999; 50,000 to 99,999, and 1000,000 to 249,999.*

A. W. W. A. Figures Used

The information regarding the water supply in these smaller cities was secured through the courteous assistance of Mr. B. H. Little, Secretary of the American Water Works Association, from the superintendents of the water works of the respective cities. Those cities which were reported as using some method of water purification were then selected for study, and separated into three groups, according to size of population, in the following manner. The first group, composed of nineteen cities, ranged in size of population according to the United States Census of 1920, from 100,000 to 249,999. This included 46 per cent. of the population of cities of that size in the United States in 1920. The second group of twenty cities had populations between 50,000 and 99,999, and these cities had 27.8 per cent. of the population of all United States cities of this size in 1920. The third group comprising thirty-one cities, recorded at the last Federal Census from 25,000 to 49,999 inhabitants, and this group comprised 22.1 per cent. of cities in this size class in 1920. It should be borne in mind that these groups do not contain all the cities of the country of similar size but those only which replied to our questionnaire, reported using filtered or chlorinated water in 1924, and which had mortality records for the whole period 1900 to 1924. Since so many of the smaller cities were not in the United States Registration Area in 1900, and since chlorination and filtration was not as widely practiced in 1924 among smaller cities as in the larger ones, this selection naturally reduced the volume of material for study in the lower population brackets. After the cities had been classified as to size, the typhoid fever death rates for each group were computed for each year from 1900 to 1924. There was also computed the percentage of the total population of each group protected by water purification methods. The result was most interesting, as may be gathered from the accompanying graphs.

Purification Becoming Universal

A glance at the graphs clearly shows the potent influence that purification of the water supply has had in reducing the typhoid deathrate. During the first decade of the twentieth century, the mortality from typhoid fever was high in all three groups of cities, ranging from 25 to 45 per 100,000 population. Very little attempt at water purification was made during these early years. Up to 1908 less than a third of the total population of each group was supplied with filtered water and practically no water was chlorinated. But about 1907 public interest in this phase of modern sanitation became awakened and from then on such measures were rapidly adopted by increasing numbers of cities, until, in 1924, approximately 90 per cent of the combined population of these communities were using water sterilized with liquid chlorine, and above 50 pe· cent had water mechanically or sand filtered.

The efficacy of these measures was immediately evident. A decided drop in the annual deathrate promptly took place and the rate proceeded to decline regularly thereafter from year to year almost in exact accordance with the increased percentage of the total population using purified water. Much the same result was achieved in the larger cities (above 250,000 of population) the individual records for which will be discussed in the forthcoming monograph.

By 1924, the mortality from typhoid fever had decreased in all three groups to about 4 per 100,000 total population, which is equal to a decline of about 90 per cent, from the average deathrate prevailing during the first few years of the century.

A feature worth noticing is the *manner* in which the deathrate declined after the cities began to adopt purification methods. Before 1910, the mortality fluctuated decidely from year to year, but after that time, very little variation in the mortality curve is discernible.

Chlorination Is Preferable

Apparently the preferred method of water purification has been with liquid

*Cities composing group with populations 100,000 to 249,999 are Oakland, Calif.; Hartford, Conn.; New Haven, Conn.; Wilmington, Del.; Cambridge, Mass.; Lowell, Mass.; Springfield, Mass.; Grand Rapids, Mich.; St. Paul, Minn.; Omaha, Neb.; Trenton, N. J.; Yonkers, N. Y.; Columbus, Ohio; Toledo, Ohio; Erie, Pa.; Reading, Pa.; Scranton, Pa.; Providence, R. I. and Norfolk, Va.

Cities with populations 50.000 to 99,999 are San Diego, Calif.; Evansville, Ind.; Terre Haute, Ind.; Flint, Mich.; St. Joseph, Mo.; Elizabeth, N. J.; Passaic, N. J.; Binghamton, N. Y.; Niagara Falls, N. Y.; Lancaster, Pa.; New Britain, Conn.; Springfield, Mass.; Portland, Me.; Lansing, Mich.; Duluth, Minn.; Lincoln, Neb.; Allentown, Pa.; Altoona, Pa.; Pawtucket, R. I. and Tacoma, Wash.

Cities with populations 25,000 to 49,999 are Brookline, Mass.; Superior, Wis.; Decatur, Ill.; Quincy, Ill.; Muncie, Ind.; Bay City, Mich.; Montclair, N. J.; New Brunswick, N. J.; Auburn, N. Y.; Kingston, N. Y.; Newburgh, N. Y.; Poughkeepsie, N. Y.; Wilmington, N. C.; Lima, Ohio; McKeesport, Pa.; Newport, R. I.; Lynchburg, Va.; Petersburg, Va.; San Jose, Calif.; Meriden, Conn.; New London, Conn.; Norwich, Conn.; Stamford, Conn.; Richmond, Ind.; Battle Creek, Mich.; Jackson, Mich.; Muskegon, Mich.; New Rochelle, N. Y.; Rome, N. Y.; Hazleton, Pa.; Woonsocket, R. I.

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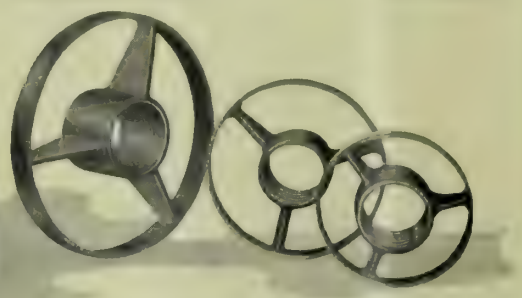


Patents Pending

chlorine, particularly in cities with populations under 100,000. The filtration method has been more generally adopted by the larger muncipalities. Of course, many cities have adopted both methods. This is generally considered the better procedure since the use of either method by itself has not been found to be thoroughly reliable.

While the foregoing matter has produced little information not already known in a general way to students of the subject, it, nevertheless, offers definite numerical data on the effectiveness of water cleansing and disinfecting processes and serves to augment previous data. It should help to demonstrate to the few still skeptical in the matter the direct dependence of typhoid fever mortality upon the quality of public water supplies. These facts also prove quite conclusively the efficacy of the water cleansing and disinfection procedures which have gained such headway in American cities during the past twenty years. Inference as to the effect of these procedures in water treatment is so clear from the graphs that it was thought to be unnecessary to compute any coefficient of co-variation between the percentages of population receiving this service and the typhoid fever deathrate.

Fundamentals of the Various Methods of Sewage Treatment

(Continued from Page 29)

sider it a safety first precaution to demand that all effluents be disinfected. This is done best by chlorine, by using it either in the form of hypochlorite of lime or as chlorine gas applied directly from cylinders. This latter method is the most common method used at present, as it is easy to install and operate; and apparatus is available to apply the gas reliably and accurately.

This general discussion of sewage treatment, upon which many books have been written, aims to give a general basic idea of the subject. If greater detail is desired, it is suggested that reference be made to the following books:

"Solving Sewage Problems" by Fuller and McClintock.

"Sewage Treatment" Separate Volume, by Metcalf and Eddy.

Redmond Gets Water Supply

The new storage dam of Redmond, Washington, is now completed and is nearly full of water, and the pipe line is well under way. Everything in connection with the new water supply has gone without a hitch and work is being finished according to schedule so that there is every reason to believe that Redmond will be enjoying an almost unlimited supply before the end of July.

For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

CATALOG SECTION

A Survey of the Leading Supplies and Equipment Used in the Construction of Hydraulic Dams, Power Plants and Auxiliary Works

Smith Tilters Used on Many of West's Largest Projects

"End-to-Center" Mixing Action a Striking Feature; Wide Range of Sizes to Fit Any Job

Dams are merely concrete placed according to a pre-determined form. Upon the soundness of the concrete rests the success and life of the whole structure; upon the dependability and stamina of the concrete mixers used depend the profits of the contractor undertaking the project.

The mixers manufactured by the T. L. Smith Company of Milwaukee have, the company states, been the choice for years of many of the largest contractors, such as The Du Pont Engineering Co., Thompson-Starrett Co., Smith Bros. of Houston, Bent Bros. of Los Angeles, Stone & Webster and A. Guthrie & Co. of St. Paul. Long experience on jobs of all kinds and sizes has clearly shown these well known builders the prime importance of unfailing dependability in their mixers when hundreds of thousands of yards have to be mixed and placed on schedule.

Some outstanding jobs on which the Smith double cone tilters have been used are Cushman Dam, Cililo Dam, American Falls Dam, Mt. Shasta Dam, Guernsey Dam, Exchequer Dam, Lake Spaulding Dam, Wilson Dam and Roosevelt Dam. Buildings of unusual importance are Willys-Knight Assembly Plant at Los Angeles, Olympic Hotel at Seattle, General Motors Building at Detroit and the Miami Biltmore Hotel.

T. L. Smith, founder of the T. L. Smith Company, built his first tilting mixer in 1900. Today, Smith construction mixers are built in sizes from 2½ cu. ft. to 112 cu. ft., this latter the largest mixer in the world. Non-tilters are built in sizes from 7 cu. ft. up to 28 cu. ft. capacity.

Probably the best known feature of the Smith line is its "end-to-center" mixing action which has never been equalled for thoroughness, speed of mixing, fast tilting discharge and self cleaning design. This action is extremely smooth and easy, making for the long life of the whole machine. Less power and fuel are required to keep one spinning at full rated capacity and there is minimum possible wobbling.

A Size to Fit the Job

Smaller contractors find the wide range of sizes of great value. The little 2½-S weighs but 730 pounds, can be towed by auto, has all features of the big machines and discharge can be operated from both sides The Smith 3½-S, giving 35 to 50 cu. yds. daily, can be supplied with power loader. 5-S and 7-S are intermediate sizes that combine ready portability with capacity for bridges and culverts—or, for city use, apartment house and hotel foundations. Smith 10-S, either tilting or non-tilting, is well-fitted for mixes such as 1-2½-4 and 1-2-4 which are now being widely specified.

View of the T. L. Smith Concrete Mixer

Models for Fast Work

14-S and 21-S are for fast placing on jobs where time is too short for the 10 cu. ft. sizes to meet the schedule yet there is not sufficient work to justify a 28-S one yard mixer. The Smith 28-S has the capacity required for larger bridges, reinforced concrete buildings, piers, dry-docks, grain elevators, dams, elevators or retaining walls. When operated in pairs or singly, the mixer control levers can be readily extended for centralized overhead operation.

The 40-S Tilter is in the "big" mixer class and is furnished on skids only. U. S. engineers, Du Pont, Thompson-Starrett and Smith Brothers are users of this model. The world's largest mixers are Smith 56-S and 112-S, two-yard and four-yard respectively. These giants mixed Wilson Dam, the project at Isle Maligne, Conowingo Dam, Exchequer Dam and Shaver Lake Dam. These models have, for 15 years, been used on the heaviest monolithic structures.

Book on Hydraulics

The McGraw Hill Company has recently issued a new book on Hydraulics, written by two well known authorities on the subject, Ernest W. Schoder, professor of experimental hydraulics at Cornell University, and Francis W. Dawson, professor of hydraulics at the University of Kansas. It was written to supply a nucleus for a basic course in the hydraulics of engineering, and while not intended as an exhaustive treatise on any one of the professional fields of specialization, it covers in a very practical way the general field describing modern practices.

The book is well illustrated, and all such illustrations show the modern forms of development, particularly as to hydraulic machinery, gates, and control apparatus. Considerable new data are presented in the chapters dealing with orifices, weirs, and pipe flows, this material having been obtained from experimental work carried on at Cornell University. The authors also introduce several new types of diagrams to facilitate computations and to give a more comprehensive view. The text is extremely well written, and should be in the library of every hydraulic engineer. The price is $3.50.

Water Co. Will Stop Service

Montecito Valley Water Company has applied to the California Railroad Commission for permission to discontinue water service, the bulk of its territory now being served by Montecito County Water District, Santa Barbara County.

"Caterpillar" tractor moving donkey engine on Bowman Dam

"Caterpillars" Make Enviable Record in Dam Building

Use of Machines Able to Disregard the Weather Cuts Cost of Construction

The "Caterpillar" tractor, manufactured by the Caterpillar Tractor Co., of San Leandro, California, and Peoria, Ill., has become an accepted and standard mobile power unit for dam construction.

The reason for this general acceptance comes about through the fact that the "Caterpillar" Tractor is a sturdy, stable machine—constructed to endure all kinds of hard work and to work in any kind of weather. Engineers and contractors have found that the machine has a wide application to various kinds of dirt moving and construction jobs.

The most dominant trait of the "Caterpillar" is that it is bigger than the weather. In rain, snow or mud, the tractor will work day in and day out without pause. Another important advantage is that with "Caterpillar" power the largest types of earth moving machinery can be successfully operated both by pulling these machines and by power take-off from the tractor. The use of these huge dirt-moving machines eliminates human power and animal power and cuts the cost of dam construction materially.

Hauls Large Shovels

Numerous instances are of record where "Caterpillar" Tractors have done almost impossible tasks. For example, on the project at Beaver Creek, Montana, a "Caterpillar" Sixty Snow Special hauled a 35-ton steam shovel for the Utah Construction Company from Augusta, Montana to the Gibson Dam site. This haul was made over extremely bad roads.

On the Bowman Dam, constructed by the Nevada Irrigation District, the "Caterpillars" hauled five 20-ton steam shovels over 17 miles of road so rough that it required three hours for an automobile to make the trip. Five different trips were made for each shovel and the work was accomplished without difficulty. The tractor was also equipped with a winch for emergency use.

In addition to hauling and placing the steam shovels, the tractors also moved a large donkey logger. The tractor, equipped with a bulldozer, was used for moving dirt as well as for other important jobs. The contractors were the W. A. Bechtel Company of San Francisco and Jasper-Stacy Company.

On the building of the huge earth filled dam for the city of Amarillo, Texas, which created a lake 3½ miles long, located 22 miles from Amarillo, a "Caterpillar" was used for hauling a huge elevating grader. One "Caterpillar" Sixty and an elevating grader, kept 14 dump wagons busy, hauling and handling 1,000 cubic yards of earth per 10-hour day.

Another important job was the construction of a huge reservoir at Ambler, Pennsylvania. Making a working schedule that would tax ordinary men and equipment to maintain under the most favorable conditions and then maintaining that schedule and completing the job in the worst three months of the year—that was the task accomplished by Charles F. Puff, Jr. Company of Jenkintown, Pa., and their fleet of "Caterpillar" tractors, while on this job.

Makes Record on Reservoir

Building a water reservoir is regarded as a dry-weather job, but the reservoir was needed. It is approximately 600 feet wide by 900 feet in length, and made entirely from earth, the earth being dug from the center and hauled around the outside, thereby building up the necessary embankments.

The job commenced in December and was completed in March. In this time approximately 100,000 cubic yards of earth was moved in rain that seemed ceaseless and mud that was endless. It is generally conceded that at this season of the year the work could have been done by no method in the world other than with the dauntless "Caterpillar." Certain it is that conditions on the job were so bad that neither trucks nor teams could possibly have been used.

Overcomes Handicap

But despite the handicap of these conditions the contractor was able to move from 1,000 to 1,200 cubic yards of earth each day, excavating it from the bottom and hauling it on an upward grade ranging anywhere up to 10 per cent, then dumping it on the embankment around the outside of the reservoir.

Four "Caterpillar" Sixties and one "Caterpillar" Thirty were used. The four Sixties hauled LaPlant-Choate dump wagons of six cubic yard capacity, and the Thirty was used in connection with a bulldozer. The earth was excavated by a gasoline shovel of 1¼ cubic yard capacity.

As the earth was dumped on the top of the embankment it was levelled off by the "Caterpillar" Thirty with its bulldozer. At the beginning of the work this bulldozer was not used, and when it started on the job it replaced approximately 29 men in levelling off the earth as it was dumped on the embankment. When a "Caterpillar" with its loaded LaPlant-Choate wagon reached the top of the embankment, the bulldozer followed closely behind, and where the load was dumped levelled it off with one sweep and was ready for the next wagon to dump.

Shovel Never Idle

The use of tractors and wagons compacted the fill, making it far better for use as a water reservoir than would have been the case had any other type of equipmnt been used.

With the four "Caterpillar" Sixties on the job the shovel was never idle a minute. There were always empty wagons lined up waiting for it to dump into, which accounts for the big daily yardage secured.

The construction of this reservoir is one of the outstanding earth moving jobs of the East, and has attracted wide attention and interest among earth-moving contractors throughout the entire section.

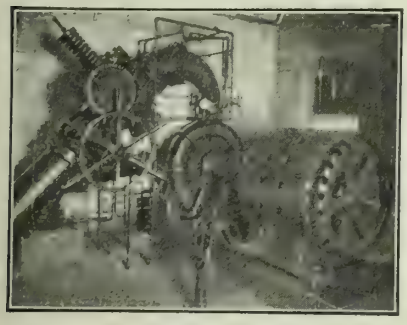
It is another notable example of the oft demonstrated fact that given proper and suitable equipment, capable men will put through their jobs, and put them through on schedule, regardless of handicaps and seemingly impossible conditions.

Centrifugal Pump Operates 16 Years with No Repairs

In 1911 the waterworks of the city of Eau Claire, Wisconsin, installed a Worthington 8-inch, split-casing turbine-type centrifugal pump.

During the 16 years which have elapsed since the pump was installed, it has been in service continually, averaging more than 16 hours a day during the period. At one time when the city of Eau Claire was installing some new pumps, it relied entirely for its water supply upon this 8-inch Worthington pump. During this period the pump ran continuously for five months, without stop.

The first repairs were required in 1927 and consisted of replacing worn



Worthington 8-inch centrifugal pump in Waterworks of City of Eau Claire, Wis. Pump has been in service for over 16 years.

shaft sleeves, the pump still being in service.

The pump is driven by a Westinghouse 2200-volt 60-cycle, 3-phase motor of the two-speed type. When operated at the lower speed, 900 r.p.m., the pump delivers 1900 gal. per min. against a total dynamic head of 180 ft. When operated at the higher speed, 1200 r.p.m., the pump delivers 2250 gal. per min. against a total dynamic head of 320 ft.

Small Tractor Shovel Has Many Uses on Excavation Jobs

Bay City Machine Has Many Exclusive Features; Is Easily Convertible

On every excavating and grading job there is a certain amount of work to be done that for various reasons cannot be carried on with the larger size shovels, no matter how many of these a contractor may have. The realization of this fact caused J. W. Fairbanks to design a small shovel which could be easily converted for use with any of the several types of excavating buckets.

After perfecting his design, Mr. Fairbanks needed for the proper development of the shovel the cooperation of a manufacturer of note and reputation who could and would put the machine on the

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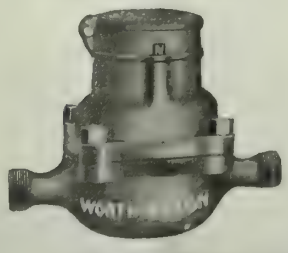

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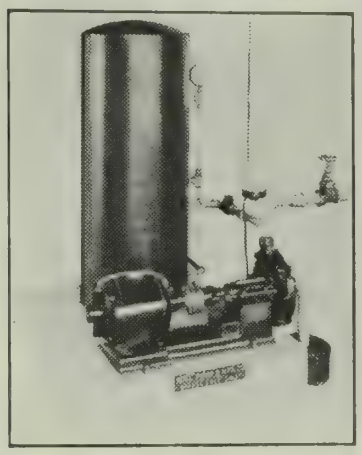

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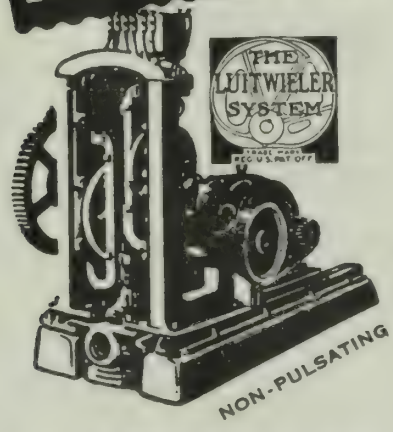

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market, and of a power plant for the successful operation of the machine. To attain this he was fortunate in associating himself with the Bay City Dredge Works, of Bay City, Michigan, and the McCormick-Deering International Harvester Company, who furnish the power plant for the tractor shovel.

After the first of these tractor shovels had been built some one termed it "the pup with a pedigree" and the name has come into general use. There are very few other pups who can boast of a pedigree equal to that of the Bay City Dredge Works "Pup."

This "pup" has many exclusive features of which the following are only a few. It has a patented self-locking worm and worm gear crowd motion, which eliminates brakes, crowding cables, friction on the boom, and their usual troubles. Crawlers are of extra heavy design, are long, and enclosed on top and both sides to keep out dirt. Power plant service can be had in every city and village the world over. The machine is convertible and can be operated for many different kinds of work. It has Timken roller bearings, fast operating speed, and travel speed up to 3½ miles per hour. The boom swings through 270 degrees of the circle. It has forged, heat-treated and machine-cut gears, and many other features that lack of space prevents mentioning.

Full information with regard to the "pup" will be gladly furnished to all who wish it on request to J. P. Sherbesman, 1901 Pierce Street, San Francisco.

Water Tight Joint Seal Adds to Efficiency of Dam

Smith Permanent Water Stop Is Simple in Construction; Installed in Many Dams

The problem of securing permanently water-tight construction joints in the design and construction of concrete dams has been one to tax the resourcefulness of engineers of wide experience. Many otherwise remarkable dams are disfigured by streams of water coursing over the downstream face. This together with the water passing through the drainage galleries also represents an economic loss or what might be termed a partial failure to achieve the purpose for which the dam is built.

The Smith Permanent Water Stop is a joint seal composed of a plastic packing which may be liquefied at any time by the application of heat.

Grade "D" asphaltum is the common type of packing used, it being placed in the dam in one or two vertical columns at each construction joint. The ordinary method of applying heat is by means of a steam pipe extending vertically through the asphaltum, although, if desired, heat may be supplied by electrical means.

One unique feature of this type of joint is that the seal may be renewed at any time during the life of the structure simply by the application of heat. Once heated the asphalt is liquefied and forced into the fissures of the concrete, thereby sealing them against the head of water. The pressure exerted by the column of liquid asphalt is more than one and one-half times that of an equivalent head of water.

The construction of this type of joint is extremely simple, in fact far more so than the common type of joint consisting of copper sheets where it is a practical impossibility to secure perfect adhesion between the copper sheet and concrete from bottom to top of the dam.

The Smith Permanent Water Stop is simple to construct and its effectiveness is not dependent upon extremely careful workmanship. Rapid deterioration of a dam structure often sets in due to constant leakage at the joints. The initial cost for a permanently water-tight joint which may be re-sealed at any time is indeed cheap insurance for the dam throughout its entire life.

The Smith Permanent Water Stop has been installed in many dams, including the Cushman Dam, Big Santa Anita Dam, Saw Pit Dam, Lost Creek Dam, Pacoima Dam, Caneadea Dam and others, including the Muscle Shoals Dam where it is now being placed. Its continued use has been due to its simplicity, effectiveness for all time and low cost.

Further information regarding details will be gladly furnished upon request.

Diesel Engine Proves Worth on Construction Jobs

Fairbanks-Morse Units Used Extensively on Excavating Equipment and as Power Supply

One of the fields for Diesel engines which has developed very rapidly in the past few years has been the use of these highly efficient prime movers in connection with construction work. Fairbanks-Morse Diesel engines are now being used on a wide variety of equipment such as power shovels, locomotive type cranes, walking drag line excavators and for dredges of the suction, dipper, clam shell and orange peel type. In addition to the mobile type of equipment used in connection with construction work F-M Diesels are also being used in air compressor plants and in Diesel electric units where the construction operations have been motorized.

There are many reasons why the Diesel engine will lower power costs, the most important being the low fuel cost and the low labor cost. Even in

cases where it is possible to buy purchased power, the demand charges become quite an item in the cost of power. In most construction work there are high peak demands due to the type of equipment used and this tends to run the demand charges up to the point where even if the energy charge is comparatively low the total power cost is high. If steam equipment is used of the donkey engine type, then it is necessary to have a number of engineers to operate the different pieces of equipment and the fuel cost of these very inefficient units mounts up very rapidly.

In contrast with the steam engine, the Diesel has a very low standby loss, as it may be started instantly without the necessity of holding steam in boilers; and the thermal efficiency or utilization of heat value in the oil is approximately five times as great.

The high efficiency of the Diesel engine also holds true in the smaller sizes. That is, the efficiency of a 60 h. p. Diesel will equal that of a 1000 h. p. steam plant. There are now thousands of horsepower of Diesel engines in operation in this country, Fairbanks, Morse & Company alone having built and placed in the field over a million horsepower.

Wide Range of Sizes

Fairbanks, Morse & Company builds a line of Diesel engines that now range in ratings from small engines driving generator sets of 18 kw. to large units of over 700 h. p. One of the most recent developments is a line of higher speed, lighter weight dredge engines in ratings of 30, 45, 60 and 90 h. p. These units all have radiator cooling and are self contained prime movers especially adapted for driving drag line excavators, power shovels, and other excavating equipment as well as saws, conveyors, pumps and similar equipment.

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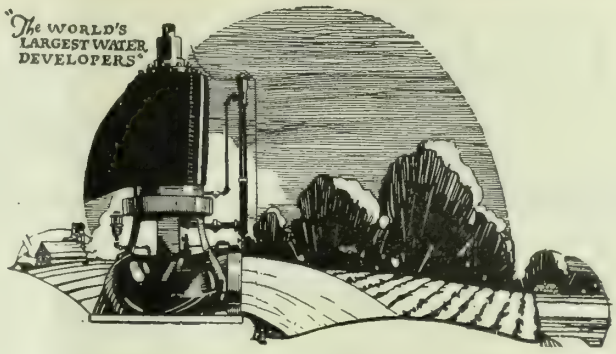
All Fairbanks-Morse Diesels are of the 2-cycle, airless injection type and the same fundamental simplicity is found throughout the entire line.

(Continued on Page 48)



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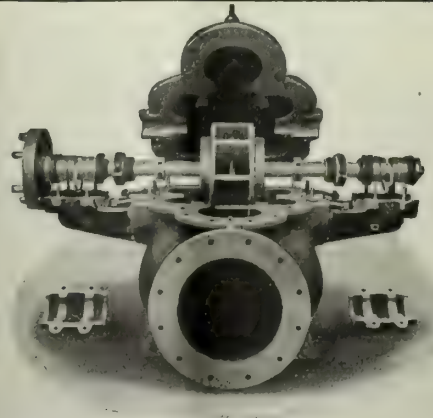

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LEGAL *and* JUDICIAL

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Water Commission Shorn of Additional Authority

Sec. 1b of the Water Commission Act declared unconstitutional.

In the case of Mojave River Irrigation District vs. Superior Court, 53 Cal. App. Dec. 70 (April 28, 1927), the District Court of Appeal declares that the provision for a review of a finding of the commission by the Superior Court is unconstitutional.

In limiting the power of the commission and holding that the determination of water rights and water controversies is within the jurisdiction of the courts and not a power of the commission, the court states:

"The determination of this proceeding then hinges upon whether or not a party having rights which may be affected by the order of the Division of Water Rights on application for permit to appropriate water has a remedy through the institution of a suit within the general jurisdiction always possessed by courts of law or equity. What may be the rights of others than the applicant which may be infringed by the granting of such a permit by the Division of Water Rights? What may be the rights to be acquired by the applicant for such a permit? What effect has an appropriation upon the rights of others? The last question may be answered first, that "its effect is merely to give a preference over a subsequent appropriator or diverter who takes under no other right or title, and to fix the date of the posting of the notice as the inception of the claim under it." (Herminghaus vs. Southern California Edison Co., 73 Cal. Dec. 1, 252 Pac. 607). . . . But the Division of Water Rights of the Water Commrssion is in no sense judicial, the legislature is without power to vest it with judicial authority, and it cannot exercise judicial functions. (Dept. of Public Works vs. Superior Court, 197 Cal. 215). . . .

The rights of others than the applicant may have originated by purchase, prescription, condemnation or otherwise. They may be possessed by individuals or by corporations, public or private. They may be for purposes of irrigation, power production, domestic uses, or what not. The right to exercise them may be continual or occasional, or at certain times only. They may be independent of others, or dependent and secondary to them. They may be vested or merely inchoate, but capable of becoming vested, and through the doctrine of relation finally attach from the date of their initiation. But concerning all of these rights ample provision has always existed for their protection. Remedies by way of injunction, mandamus, suit to quiet title, prohibition, damages and certiorari have afforded adequate protection to every interest in water heretofore or now known to the law. As to such rights no new interests are conferred in any instance by the Water Commission Act, and cases provided by section 1b are not those for which courts of general jurisdiction have lacked a remedy.

In appraising the rights to be acquired by the applicant for a permit to appropriate water it must first be observed that the extent of the right is merely permission to make claim to a water right, and to subsequently acquire title thereto. Title is not conferred or even confirmed by the order of the Division of Water Rights. The effect of such an order may be nullified by the decision of the court in a proper proceeding. If the Division of Water Rights improperly refuses a permit, mandamus will issue to require that it be granted. If permission be wrongfully granted those having rights which are prejudiced thereby have ample protection through the well-established remedies above mentioned, and even if, as argued by some of those who uphold the constitutionality of the section, it were to be held that since the amendment of 1923 the Division of Water Rights acts in a quasi judicial capacity in passing upon applications for permits, its decision might be reviewed upon certiorari."

Municipal Money Cannot Be Used For Political Purposes

Ruling of Supreme Court of interest to irrigation district directors.

The City of Los Angeles in presenting a bond issue to the electors for the purpose of raising funds to purchase an electric system, used some twelve thousand dollars of public money for advertising, banners, hand bills and other means of enlisting public support for the bond issue. A suit is brought to require the repayment of these expenditures on the ground that the same were illegal.

The Supreme Court in holding that such expenditures were improper states in the case of Mines vs. Del Valle, 73 Cal. Dec. 661:

"That the powers of a city of a proprietary character are given a more liberal construction than those which are strictly governmental in character is settled beyond controversy by the decisions of our courts, and this rule is approved by our best text writers. But, conceding this to be true, it does not follow that a municipality in exercising its powers in its proprietary capacity has the authority to do any act or thing which its officers may think necessary for the proper conduct or maintenance of the business in which it is engaged . . . . Appellants contend that as the money was paid out honestly and in the belief that it was within the authority of the Board of Public Service Commissioners to use the funds of the City in payment of said expenditures, no recovery can be had against appellant."

Quoting from the case of Osburn vs. Stone, 170 Cal. 480, the court states:

"There is no question of the good faith and honesty of intention of said officers in auditing and paying out said money, but as the contract under which it was expended was not within the powers of the board, its payment was illegal and said officers were held liable for its payment.

The court further quotes from the Osburn case, as follows:

"Their (city officials) modes of procedure in all matters of expenditure are pointed out with particularity. They are given by law a legal adviser, and, if not, are fully empowered to employ one. There is no occasion whatsoever for their taking any step without such advic. There is no reason for their ever making any illegal expenditures of the public's moneys. To countenance the making by these officials of an illegal expenditure in one case, is to open wide the door for like expenditures in every case."

Water Company Liable for Failure to Deliver

Court states rule of damages for loss of growing crops.

In the case of Chrisman vs. Southern California Edison Company, 53, Cal. App. Dec. 364 (May 20, 1927), a judgment was given against the water company for failure to deliver water for the growing of crops. In fixing the measure of damage the Appellate Court states:

"The damages to growing crops are to be ascertained by first determining from the evidence the market value of the probable yield of the growing crop if the water had been furnished as agreed, and then deducting therefrom the reasonable cost of marketing and producing such crops, and also deducting therefrom the net market value of the crop actually produced."

Evidence of Sales Not Allowable on Direct Examination

Condemnation case reversed by reason of error of judge in allowing improper evidence of values.

In the case of Los Angeles vs. Pedersen, 53 Cal. App. Dec. 6 (April 25, 1927), the Appellate Court states the rule as to market value on condemnation to be as follows:

"The true rule is to determine the market value of the property as it is found, considering all of the elements of value inclusive of all of the uses and purposes for which the land is or may be adapted."

Score San Francisco Attempt To Evade Restrictions

Officers of political subdivisions cannot disregard restrictions on authority although the results may be laudable.

In the case of Mahoney vs. San Francisco, 73 Cal. Dec. 643 (May 27th, 1927), the Supreme Court holds the lease of the city with the Spring Valley Water Co. (which in effect was a contract of purchase) to be void and an invasion of charter and constitutional provisions, stating as follows:

"We do not understand that the force and effect of the constitutional restrictions may be avoided—however beneficial such an avoidance may appear to be to the municipality by permitting it to carry forward its plans— If this be the rule of construction the restriction provisions of the constitution and charter would become practically nullities and there would be no opportunity for taxpayers to be heard as to the incurring of indebtedness or that would become a charge upon the future income or revenue of municipal and public corporations. It would practically put an end to bond issues as provided by the constitution with respect to the incurring of future indebtedness or liability."

A Theory Differing From the California Law Enunciated

Under Washington law current expense warrants have the first call on funds of irrigation districts.

It appeared that the treasurer of Burbank Irrigation District of Washington insisted in calling and paying the warrants of the district according to the numerical order of their issue and registration. That he applied all funds received from assessments for the payment of registered warrants, regardless of the year for which the funds collected were levied.

In the case of Burbank Irrigation District vs. Treasurer, 255 Pac. Rep. 360 (April 18, 1927—Wash.), the Supreme Court follows the Colorado rule and holds:

"—It seems to us that taking this act in its entirety; considering the purpose to be accomplished; realizing that water must be furnished this year or there will be an entire failure of that purpose; that the land is without value except as supplied with water—and having in mind that it is the duty of the Court, when possible, to construe the various sections of the legislative acts so that the real purpose of the act may be accomplished, we hold that the current expense warrants for operation and maintenance for the present year have the first call on the money raised by the levy and assessment for the expense fund for this year."

Rules On Water Supply To Outside Territory

A municipality can only furnish water to outside territory when it has express or implied authority to do so.

In the case of Richards vs. City of Portland, 255 Pac. Rep. 326 (Apr. 19, 1927), the Supreme Court of Oregon lays down two rules of law concerning the supply of water to outside territory, as follows:

"It is elementary that a municipality, acting either in its governmental or proprietary capacity, can do so only by virtue of express or implied authority conferred upon it. Ordinarily, the jurisdiction of a municipality

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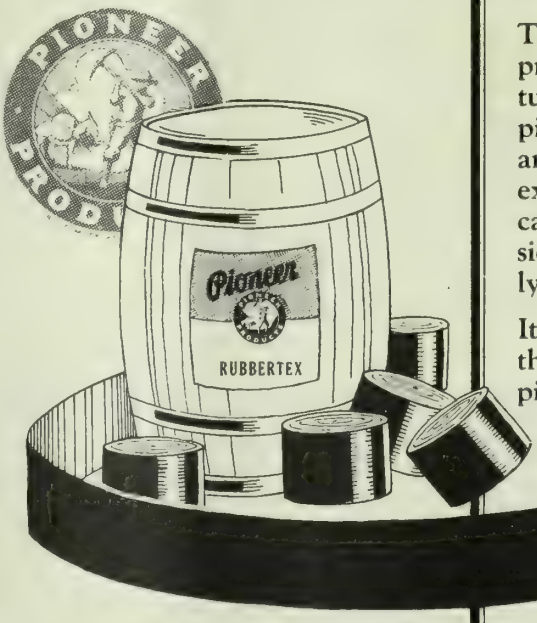

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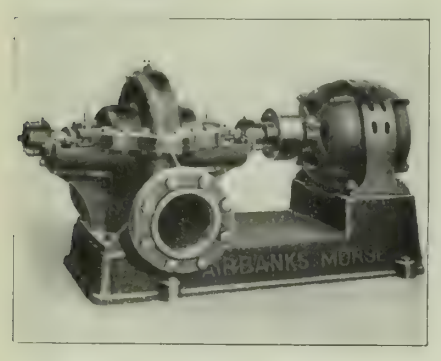

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ceases at its boundaries, and, for it to exercise extra territorial jurisdiction, its power to do so must be clearly expressed.—It is to be borne in mind that the charter of the City of Portland is a grant and not a limitation of power. Power granted to supply the inhabitants of the City of Portland with water does not carry with it the implied authority to furnish water to those who are not its inhabitants—"

The court finds that by amendment to the charter the city was entitled to furnish water outside of the city limits and states:

"It is true that, if the city, in supplying water to outside districts, was engaged as a public utility, it would, by virtue of such status, be required to serve all water consumers therein without discrimination. Under such circumstances the law would impose the same obligations upon the city in supplying water as it would upon a private corporation likewise engaged."

The court holds, however, that the city was not acting as a public utility but only under private contract, and such contracts having expired the city was under no duty to continue water service to outside lands.

Can Prohibit Swimming In City Water Supply

Police power of municipality extends over water supply under Federal jurisdiction.

In the case of Brown vs. City of Cle Elum, 255 Pac. 961 (Wash. April 28, 1927), the Supreme Court of Washington holds that the states may exercise their ordinary police power over Federal forest reserves within their territorial limits, and especially where exercise thereof has to do with restraining acts of private citizens, looking to preservation of public health.

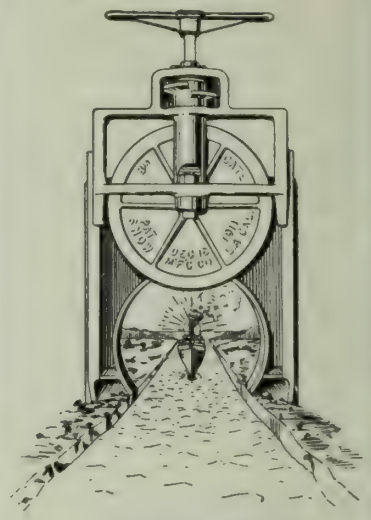
Private citizens leasing lands in United States forest reserve along a lake, from which the city took its water supply are not entitled to injunction preventing city from enforcing an ordinance prohibiting swimming, fishing and boating in the lake, where the ordinance was enacted under a delegated police power for the protection of the purity of the city's water supply.

Diesel Engine Proves Its Worth on Construction Jobs

(Continued from Page 45)

The engines utilize what is known as two stage combustion. The simple fuel pumps inject the fuel into a combustion space at the top of the cylinder. This combustion space is separated from the cylinder proper by a small neck and when the fuel is injected, at the top of the piston stroke, the air which is flowing up through this neck meets the injected fuel and a considerable turbulence results which thoroughly mixes the air with the fuel. The compression pressure is approximately 500 pounds per square inch and when air is compressed to this pressure the temperatures rises to

SPECIFY



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approximately 1000 Deg. Fahrenheit and so the fuel is ignited by this highly heated air. No ignition devices of any kind are required on either the smallest engines or the largest.

As these engines are of the 2-cycle type no inlet or exhaust valves are required as ports in the cylinder walls and the pistons perform these functions. The elimination of valves reduces the number of operating parts and the number of adjustments required in the field so that these engines are extremely simple to operate.

The construction of the cylinder and cylinder head is also simplified so that it is possible to use castings which are free from complications and it also makes it possible to secure large cooling water passages in both the cylinders and cylinder heads.

The practical simplicity of the Fairbanks-Morse Diesel engine has had much to do with increasing the popularity of this type of prime mover. This organization now builds more than half the Diesel engines which are built in the United States today and the production is well up towards 200,000 h. p. per year. There are now more than 15,000 of these units in service. In addition to playing an important part in the construction of irrigation power and water supply projects, these engines have also played an important part in the operation of irrigation and drainage systems. In the Rio Grande Valley alone there are more than 50,000 h. p. of Fairbanks-Morse Diesel engines operating irrigation pumps and in the Florida Drainage Districts nearly as many are handling drainage pumping.

Files on Arizona Project

Application for a permit to dam the Colorado river at Marble Gorge, ten miles north of the Grand Canyon national park, and thereby to create a reservoir which it is claimed will store 15,000,000 acre feet of water, for the irrigation of 2,000,000 acres and the generation of 2,000,000 horsepower, has been filed by Senator Fred T. Colter, of Apache county, Arizona, president of the Arizona Highway Association. The project, known as the Colorado-Verde plan, proposes to bring the water from the Colorado river at Marble Canyon to the valleys of the Salt and Gila rivers by means of about a hundred miles of double-bore tunnel. A dam about half the size of the proposed Boulder Canyon dam would be built to make the plan possible. Senator Colter says that he made the filings as a protective measure in the event that the future would prove the Colorado-Verde system superior to the others filed on.

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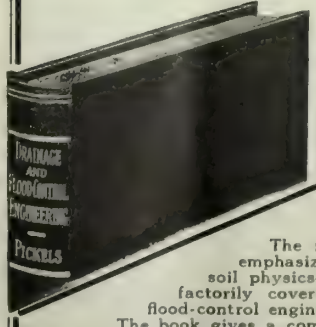

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OVERHEAD IRRIGATION

OVERHEAD IRRIGATION ON VANCOUVER ISLAND

THE subject of irrigation has come in for considerable discussion in Victoria, British Columbia, during the past summer. The Victoria Colonist has published a number of articles with the object of putting before its readers the pros and cons of irrigation. Referring to the districts immediately surrounding Victoria, this paper says that the controlling reason in favor of irrigation is the high price of lands in these districts. "To say that it is the result of inflated values is no argument," says the Colonist, "because, supposing the intending investor were to pass by the high-priced cleared lands and buy bushland at an extremely moderate price, the cost of clearing it and the loss of time before any returns can be made will bring up the total cost to approximately that of the cleared land which can be operated at once as a growing concern.

"But in reality this is putting the case much too favorably. The facts in numberless instances prove that only in rare exceptions does a man get his interest on his invested money and his labor wages. The story of practically all farm holdings is that a man thinks himself very lucky if he can make enough to pay him the equivalent of a very moderate wage, considerably less than that earned by the majority of eight-hour workers in town, and all his investment does for him is to assure him continual employment. This is looking at the matter with cold calculation, stripped of all the sentiment that is supposed to envelop country life, and it is because people are so much in the habit of shirking this aspect that the history of farming, to speak locally, at any rate, is so thickly strewn with the wreckage of lost investments and disappointed hopes.

Truth Must Be Grasped

"Thus the truth stands clear and inexorable that high-priced land must be made to produce sufficient high-priced crops to make the proper returns on the investment. This is axiomatic, but until it is firmly gripped valuable money will still continue to be literally thrown away in heart-breaking and ruinous waste. And, next, it is almost equally evident, at any rate, to anyone who has had even one year's experience on the land that it is impossible to get this super-production without water. Occasionally a piece of land can be found so favorably situated as to be moist practically all the summer, but it is rare enough to be negligible as an argument, and any visitor to the environs of Victoria at this time of year can see that the crying need everywhere is water. Town people have it and their gardens are filled with luxuriant vegetables and fruit at a time when the farm garden is a wilderness. Water, and only water, can bring to its full fruition the goodness of the soil, for sunshine and mildness of climate we are famous for. It is only necessary to add a water supply that can be used when needed to add, without any exaggeration, millions of dollars to our revenue per year.

What Water Has Done

"Irrigation is as old as the Pharaohs, and wherever it is used it changes the desert into a garden. Millions of acres in the United States and Canada have been reclaimed to fruitfulness and wealth by it, and although this locality cannot by any means be classed with "dry belt," the fact is incontestable that it alsowould feel the benefit if water were to be had when required. Many people have heard of the great Seabrook truck farms at Bridgeton, N. J. The average rainfall there is higher than it is here, yet the Seabrook Company found that it paid to put in an expensive installment of water pipes for the purpose of watering their strawberries about three weeks in the year. As one Eastern grower put it, "The growing game is too uncertain, without irrigation, to put my time, money and energy into it; without irrigation it is not a business, it is a game of chance."

It is the overhead system that is being advocated in Victoria, the cost of the installation of which is estimated at $300 an acre. But as the results of experiments of growing crops with and without irrigation at the Dominion Experimental Farm at Sydney show an increase of $600 an acre in one season in the growing of raspberries on irrigated land, and compared with the same crop grown on non-irrigated land, and corresponding increases in other crops, this initial cost would not appear to be high, as the increase in crop yield in one season would be double the cost of installation.

Bids on San Gabriel Dam

(*Continued from Page 18*)

by a group of interested individuals representing some of the smaller communities affected by the building of the structure. Just why the protest was submitted at that particular time is problematical, especially since these same individuals have many times before been called upon to submit their views, and a board of eminent engineers selected to hear their protests and make recommendations to the district accordingly.

Protest Called Unfortunate

Unless prevented by a court injunction it is probable that the supervisors will award a contract for the construction of the San Gabriel dam to one of the bidders, as all bids are well within the engineering estimates. It is considered unfortunate that there should be any move to protest the construction of the dam as now planned, as this may delay the work for several years. The general feeling is that there already has been enough controversy over the project. The matter was believed to have been settled when the supervisors accepted the report of the engineers who were appointed at the suggestion of the Los Angeles Chamber of Commerce to settle for all time the questions in dispute, (See Modern Irrigation, April, 1927).

There is doubt that the contention of San Gabriel Valley cities that because a dam of certain height was planned before the bonds were voted, the flood control district cannot erect a dam of lesser height, is well founded. No part of the flood control scheme has been carried out just as it was originally planned. Many assert that no court will sanction a useless expenditure of money, just because the bonds were voted to spend that money.

Then too, it is argued, the control of the San Gabriel River will not be complete with the construction of the dam, but other protective works must be built to safeguard the dam, such as sediment basins, diversion canals, etc., which the extra money will permit, according to the present plans. If this money is spent for a higher dam than is now planned the district will have to come again to the voters at some future date for monies for this additional work. The surplus of the present bond issue would be utilized for this purpose, according to present plans.

Pumping Equipment Keeps Pace with Increasing Demands

(*Continued from Page 32*)

000.00 to $20,000.00 for similar steam station operating at the same time.

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Turbine pumps, reciprocating pumps and as a matter of fact, all pumps have their special field, but in recent years the tendency has been toward electrically driven pumps where local conditions permit. The great increase in the ratio of electrically driven pumps to pumps driven by other means may be said to be due to the following:

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It has been said by one of our country's famous men that "Service is the greatest commitment in life," and I know of no instance where this statement is more true than in the supplying of water for the needs of our growing population. Therefore, in laying out pumping systems, the factor of service, should be utmost in the mind of the designer and equipment should be selected to best meet the demand and conditions.

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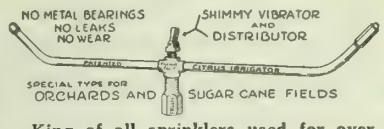

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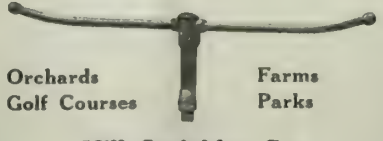

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SURVEY *of* HYDRAULIC DEVELOPMENT

A summary outline of developments contemplated on Western projects which have been announced during the month

Filtration and Chlorination

ANACORTES, WASH.—The city council has rejected all bids which were submitted for the construction of the two new 500,000-gallon filter units. New bids will be taken. Three were submitted before, the highest by the California Filter Company for $25,746, and the lowest by the Lidral Construction Company for $22,950.

CHEHALIS, WASH.—At the regular meeting of the city council of Pe Ell, plans were discussed for the installation of a new filtration plant. J. W. Donahue, water superintendent, was authorized to secure the service of an expert engineer to make an investigation and render a report with recommendations.

Irrigation Development

SEATTLE, WASH.—It is estimated that the Columbia River Basin Project will cost approximately $150,000,000. This amount is being asked as an appropriation from the next session of congress.

CHICO, CALIF.—Word is received that a movement is on foot for the organization of a new irrigation district to take water from Big Chico Creek for the irrigation of adjoining lands. The plan is yet in a formative stage.

SAN FRANCISCO, CALIF.—Charles F. Bradford, San Francisco, has applied to the state department of public works, water rights division, for permit to develop 40,000 acre feet water to irrigate 20,000 acres in Eldorado County.

EL CENTRO, CALIF.—Election will be held July 1 to vote on a $50,000 bond issue for funds to remove the 8th St. ditch of the Imperial Irrigation District. The district will bear a portion of the expense and the city will pay $45,000 of the total cost which will be about $61,000.

EL CENTRO, CALIF.—Plans of M. J. Dowd for the generation of hydro-electric power upon the various canals of Imperial district have been approved by the board of directors. The plan will now be submitted to the state bond certification commission for their approval before going further with the project.

PATTERSON, CALIF.—Bonds in the sum of $1,215,375 have been voted by the West Stanislaus Irrigation District, Patterson, for work in the district. Of this sum, $854,265 will be expended on work as follows: Pumps, 45 cu. sec. capacity, 32 units to cost $88,000; motors and automatic control, 32 150 h.p. motors, $81,920; main canal, involving 191,000 cu. yd. earth excavation, $58,500; 7 buildings for pumps, etc., $100,000; unlined main laterals, 155,000 lin. ft., $31,000; concrete-lined main laterals, $263,000; sub-laterals, $10,300; concrete lining, main canal, $90,900; transmission lines, copper, $2933; poles and insulators, $4067; outdoor disconnects, $3000; pump station transformers, $25,000; sub-station transformers, $32,500; lighting arresters, $570; incoming line panels, $1600. W. F. Woolley, Patterson, chief engineer.

SAN FRANCISCO, CALIF.—C. T. Henderson of San Francisco has applied to the state department of public works, water rights division, for permit to divert 340,000 acre feet of water from Bear and Cache Creeks in Colusa and Lake counties for a 40,000-acre irrigation project in Yolo and Solano counties for industrial and domestic water uses in Antioch, Pittsburg and Crockett. Proposed work involves a $780,000 reservoir and distribution system.

MARYSVILLE, CALIF.—Directors of the Nevada Irrigation District have just made a trip of inspection over the properties of the district, the main reason for this trip being to determine the feasibility of the plans of extensions which are now contemplated. Project No. 3 contemplates the use of both Deer Creek and Bear Creek for the storage of water. A reservoir at Scotts Flat storing 13,000 acre feet, and another reservoir at the Parker site will store 39,000 acre feet. The total cost of the contemplated extensions is estimated at $4,702,580.

BENGAL, INDIA.—The Bengal government has decided to proceed with the construction of the Damodar Canal, according to Assistant Trade Commissioner Joseph B. Fitzgerald, Calcutta. The total cost of the canal is estimated at 7,814,981 rupees (value of rupee is approximately $0.36), and the construction will occupy about six years, but it is considered that the work will be sufficiently advanced in the fifth year to enable a portion of the area concerned to be supplied with water. The canal has been planned for the purpose of irrigating 196,000 acres of land, mostly paddy, in the Burdwan and Hooghly districts. Details are available under reference India No. 52611.

PHOENIX, ARIZ.—An agreement has been reached between the Salt River Valley Water Users' Assn. and the Verde Irrigation District, whereby about 80,000 acres of land in the Paradise and Deer Valleys will be placed under an irrigation system similar to that in use in the Salt River Valley. The project will involve an expenditure of $5,000,000 or more, and calls for the construction of one or more dams and reservoirs similar to the Horse Mesa dam, with power plants, canals, power lines, etc. C. C. Cragin is superintendent and engineer for the water users' association. The agreement settles certain disputed points regarding water rights which have been the subject of controversy for many years.

MANILA, P. I.—The Laoag-Vintar Irrigation System, which has been in operation for some time in the Province of Ilocos Norte in north Luzon, will be rebuilt at an estimated cost of approximately $700,000, according to Trade Commissioner O. M. Butler, Manila. The former system of irrigation, which was of the rock-fill type, was partly destroyed by a typhoon about two years ago, and for this reason the gravity type will be substituted, notwithstanding the greater cost of the latter. It is not yet known whether the bureau of public works, at Manila, which supervises all irrigation projects undertaken by the government, intends to carry out the construction of the new system by administration or by contract. Work will be undertaken very shortly.

Pumping Equipment

LINDSAY, CALIF.—City has started construction of a steel, concrete and tile pumping plant building at the city park site. Present work includes steel storage tank and two large reservoirs, providing a total capacity of 500,000 gallons. Fire pressure pumps will be included.

GLENDALE, CALIF.—Demand due to growing population calls for construction of six new reservoirs and several new pumping plants, a central sub-station, and material additions to various water mains. Some of this work will have to be done in the distant future, as the budget for this year allows only a certain percentage of these improvements.

INDIO, CALIF.—E. Q. Sullivan, division engineer, state highway commission, Box 137, San Bernardino, desires bids for drilling a well on the state highway maintenance site at Indio. Depth of well to ensure good supply. Casing to be 12-in. 12-gauge, double well casing, 21 ft. starter, ¾x6-in. shoe. Two bids are wanted, viz.: one for drilling only and one for drilling and materials. Bid to be in price per foot which will include all expense of moving rig, placing casing, perforating and completion ready for pumping.

Reclamation and Drainage

HOLLYWOOD, CALIF.—The contract for the Laurel Storm Drain was recently let to the H. W. Rohl Company. The amount of their bid was $395,387.15 which includes resurfacing and other work. The bid on the drain alone was $373,000.

ONTARIO, CALIF.—A mammoth flood control and water conservation project is now in the process of being organized, according to Chairman C. S. Crain, of the San Bernardino County Board of Supervisors. Both San Antonio and Cucamonga Canyon districts are involved in the project.

ANAHEIM, CALIF.—With the signing of the Orange County Flood Control bill by Governor Young, it is expected that the machinery created by the measure for conserving the water resources of the district will immediately be placed in operation. Rumor has it that the firm of J. B. Lippincott, consulting engineers, will be commissioned to handle the work for the district.

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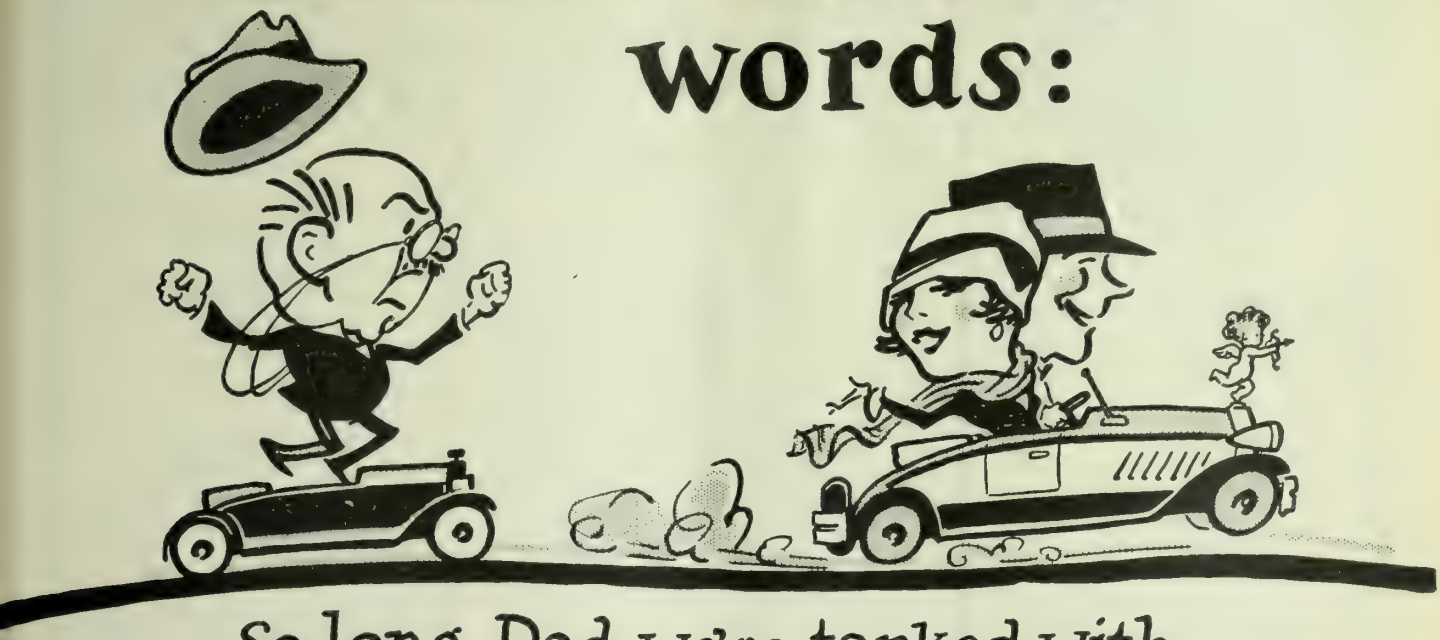

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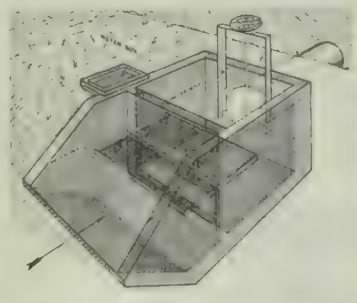

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LA HABRA, CALIF.—Interested parties are requesting the Los Angeles Flood Control District, and the Orange County Flood Control District to authorize immediately a dredging program to control the flow of Coyote Creek. The menace of this creek is considerable during the flood period.

LOS ANGELES, CALIF.—County surveyor has completed preliminary survey for a comprehensive storm drain plan to include Pasadena, South Pasadena, Alhambra, San Marino, San Gabriel, Rosemead, and Wilmar, estimated to cost $2,500,000. The supervisors will probably take the matter up at an early date.

SAN GABRIEL, CALIF.—City trustees have voted to call an election in the near future to vote on a $55,000 bond issue for the construction of a storm drain system in Longden Ave. and Las Tunas Drive, and in other streets. Plans submitted by City Engineer Wright have been approved by the board. They call for 1900 ft. of 48-in. pipe on Longden from Roses Road to the bridge on Longden; 1100 ft. of 30-in. pipe from Santa Anita to San Marino on Las Tunas; 800 ft. of 50-in. pipe from San Marino to Del Mar on Las Tunas and 2000 ft. of 60-in. pipe from Del Mar to the bridge on Las Tunas. Total of the estimate as submitted by the engineer was $53,546.65 but it was thought advisable to make the bond issue $55,000 to carry possible contingencies.

MELBOURNE, AUSTRALIA.—The Australian Federal Development and Migration Commission has approved public works estimated to cost about £6,158,000, according to Consul Thomas H. Robinson, Melbourne. This commission is functioning under authority of the Federal Parliament to investigate the resources of the country with a view to increasing migration to sparsely settled regions. The plans for Victoria include the construction of roads and irrigation channels, at an estimated cost of £1,084,000. Plans for Western Australia involve the creation of 6,000 new farms, the reclamation by drainage of about 280,000 acres, and the construction of railways, at a total estimated cost of £4,000,000. In South Australia a water conservation scheme has been approved.

Reservoirs and Dams

LOS ANGELES, CALIF.—The city and county have united upon the construction of the Big Tujunga Dam. The estimated cost of this structure is $4,000,000.

POMONA, CALIF.—Construction of a 5,000,000-gallon reinforced concrete storage tank will be commenced next spring. The cost is estimated at $50,000.

TACOMA, WASH.—The city officials are now selecting the site for the new reservoir for the east side water supply system. This reservoir will have a capacity of 25,000,000 gallons.

ANGELS CAMP, CALIF.—The Calaveras Water Users' Association has applied for the right to store 12,000 acre feet of water in Highland Creek. The estimated cost is $50,000.

POMONA, CALIF.—Plans are being formulated for the installation of a new city water system in conjunction with an entirely new fire system. A portion of this plan is the construction of a 5,000,000-gallon reservoir in the eastern section of the city.

IDYLLWILD, CALIF.—C. L. Emerson, manager of Idyllwild, Inc., has announced that a dam 60 ft. high will be built to create an artificial lake in Strawberry Creek. The dam will provide about 60 acres of water surface.

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CHEHALIS, WASH.—Early in July the voters of the city will decide the fate of the proposed $80,000 bond issue, necessary for improvements to the water supply system. It is proposed to build a 5,000,000-gallon reservoir.

WALNUT CREEK, CALIF.—Engineer R. Nass has submitted his estimate of the cost of the new water supply system. It is proposed to build a reservoir of 78,000,000 gallons capacity, and this together with pumps, filters, a 14 and 10-inch pipe line is estimated at a total of $77,165.

PASADENA, CALIF.—The construction of a new reservoir is being planned for the city water department. The site of this structure has not as yet been decided upon, but proposals contemplate a location somewhere near the Glendale-Pasadena line. The capacity of the line will be 1,000,000 gallons.

JEROME, ARIZ.—The Salt River Valley Water Users' Association and the Paradise-Verde Water Association have reached an understanding relative to the Verde waters, and will proceed to finance and direct the work of constructing storage dams and canals for the storm waters.

NEW BRUNSWICK, CANADA.—An act authorizing the construction of a hydropower plant in New Brunswick, Canada, costing approximately $23,000,000 was passed recently by the provincial legislature, and a charter for its construction has been granted by the provincial government, according to Consul B. M. Rasmusen, Moncton.

SAN DIEGO, CALIF.—The city is planning a new dam to be located upon the Tijuana River approximately 13 miles southeast of Tijuana. This will be known as the Garcia dam. Methods of financing the project are not as yet determined, as the location being out of the United States will complicate matters considerably.

OAKLAND, CALIF.—Bids are being received by East Bay Municipal Utility District, Ray Bldg., Oakland, for the construction of Lafayette Dam, to be rolled earth-fill type with puddled clay core, 170 ft. maximum height, 1855 ft. crest length, with 6-in. concrete face. Work involves 2200 cu. yds. concrete cut-off, 6000 cu. yds. waste excavation (spoil banks), 45,000 cu. yds. puddle trench fill, 1,887,000 cu. yds. embankment in place, 17,500 cu. yds. small broken rock or screened gravel covering in place, 10,000 cu. yds. reinforced concrete pavement, 1000 cu. yds. overhaul of embankment, 2800 lbs. metal (concrete conduit and pipes), 25,000 cu. yds. excavation (conduits), 20,000 bbl. Portland cement, 800,000 lbs. reinforcing steel in place, 2600 cu. yds. reinforced concrete in place, 1 check valve in place, 6 slide gates in place, 6 metal trash racks in place, metal ladders, landings, floor plates, I-beam grillage, hoist supports and screens in place, 5 sets of glazed steel window sash in place, 1 wooden door complete, 5200 lin. ft. 6-in. vitrified drain tile, 1000 ft. 8-in. vitrified drain tile. Arthur P. Davis, chief engineer.

Sewage Disposal

LIVINGSTON, CALIF.—City trustees are planning to call for bids shortly for the construction of water and sewer systems for which a bond issue of $84,000 has been voted. C. E. Bates, city engineer.

BURBANK, CALIF.—Final approval of the Los Angeles-Burbank sewer contract is now in the hands of the Burbank city council. By this contract Los Angeles will construct the sewer line through Burbank from a point in Glendale 2000 ft. east of the east line of Burbank to the west line of Burbank, 13,000 lin. ft. The estimated cost is $220,000, which Burbank will pay.

ANAHEIM, CALIF.—J. L. McBride, former county road commissioner, has been elected chairman of the executive committee of the joint outfall sewer board. The board consists of representatives of Anaheim, Fullerton, Orange, Santa Ana, Placentia Sanitary District, La Habra and Garden Grove Sanitary Districts.

Waterworks

PHOENIX, ARIZ.—City Manager Henry Rieger made a report before the Chamber of Commerce advocating entirely metered service to stop the extravagant use of water.

THERMOPOLIS, WYO.—A new waterworks system costing $300,000 is to be installed in the very near future, according to reports obtained from the city council.

SANTA BARBARA, CALIF.—Funds for the new city water mains will soon be available according to C. W. Moore. This will allow the much needed extensions to placed immediately.

BLOOMINGTON, CALIF.—Approximately 104,000 feet of new pipe will be required by the city to increase the size of the water system. The estimated cost of the necessary work is $60,000.

LA HABRA, CALIF.—City trustees are considering a proposition to vote $120,000 bond issue to purchase the existing water company and construct additions and betterments.

SHAFTER, CALIF.—The voters will be asked to approve a $30,000 bond issue for improvements to the city water system. The date for the election will be late in July or early in August.

BELLINGHAM, WASH.—The voters of the city will be asked on August 9th to approve a $250,000 bond issue for the improvements necessary for the city water system.

HANFORD, CALIF.—Voters have formed the Armona Public Utility Water District, which will provide a domestic water system for the community. The cost is estimated at $30,000.

POMONA, CALIF.—The Narod district is petitioning the board of supervisors for additions to the district's domestic water supply. The action upon this matter will be taken sometime this month.

EVERETT, WASH.—Plans for the construction of the new water main 2½ miles in length were announced recently. This will connect up the Beverly Park District. Estimated cost is $60,000.

BAKERSFIELD, CALIF.—Shell Oil Co. has plans underway for the construction of a 10-inch pipe line from Coalinga to Taft, with an 8-inch lateral into the Mt. Poso oil fields. Estimated cost of the project, $3,500,000.

PASADENA, CALIF.—Resolution of intention No. 5883 adopted by city for 4-inch cast iron water mains in Titley Avenue from Foothill Boulevard to a point 30 feet north of the south property line of the Titley Tract. Bessie Chamberlain, city clerk.

TACOMA, WASH.—The state has granted a permit to the city authorizing the use of water for a new $2,000,000 industrial water system. The new development is centered around Kapowsin, in eastern Pierce County and grants appropriations of 625 feet from the Puyallup, 100 feet from Voight Creek, and 80 feet from Kapowsin Creek.

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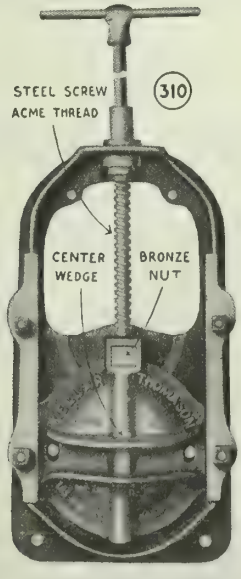

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BURLINGAME, CALIF.—Residents of this city voted at the last election a bond issue for $310,000 to be used for additions to the fire and water systems. The fire department will receive $85,000 and the water department will be allowed $225,000 necessary for the extensions to the water mains.

STOCKTON, CALIF.—The water systems of the California Water Service Corporation of this city contemplate immediate extensions to the system, according to advice received from C. B. Jackson, president of the corporation. The system as a whole is inadequate for the present needs, with the exception of Tuxedo Park.

WOODLAND, CALIF.—Plans are being formulated for improvements to the city water system which has been found inadequate for present needs. These plans are not definite as yet, but City Engineer Asa G. Proctor is making the preliminary investigations and expects to render a report soon to the city council.

SAN BERNARDINO, CALIF.—There has been organized another water company in the Bear Valley district, to be known as the Treasure Island Mutual Water Company. The directors of this company are H. H. Garstin, Redlands, and H. O. Wheeler and T. C. Ridgway of Los Angeles, Calif. Operation will start immediately.

EVERETT, WASH.—Thomas C. Fleming, chairman of the county board of commissioners, declared that there is a dire necessity for the construction of a cheap industrial water supply for the city. Other civic bodies are taking up the issue and expect to obtain some real action in the near future.

SAN DIEGO, CALIF.—City Manager Lockwood has requested the city council to appropriate $250,000 in a bond issue for the installation of new water mains, hydrants, and other water works development. The cost is distributed as follows: 16-inch cast iron pipe line from Mission Hills to Pacific Beach, $150,000. An 8-inch cast iron line from Boundary Street north to Euclid Avenue, cost $26,400. Installation of a 500,000-gallon tank and pumps near Van Dyke and 43rd streets, cost $50,000. A 12-inch cast iron main of Cajon Street, cost $12,000. Installation of fire hydrants in Normal Heights addition, cost $11,600.

Unit Bids

MONTEREY PARK, CALIF.—Elliott & McKenna, Batiste, Orange County, awarded contract by city June 20, at $21,068, for (1) construction of a 2,000,000-gal. concr. reservoir at $20,140, (2) 55 cu. yds. concr. fill at $10 yd., (3) graded roadway $150 lump sum, (4) 380 ft. 10-in. cement pipe drain at $228 complete. Time limit, Nov. 1. Composition roof is to be put on later under separate contract. O. A. Gierlich, city engineer.

ELLENSBURG, WASH.—Bids received by U. S. Bureau of Reclamation June 3, for the construction of a 12-mile section of the Kittitas Div., Yakima Project, including main canal, South Branch Canal, and syphons at main canal. Work is located on the Northern Pacific Ry. near Easton, and involves 235 acres clearing and grubbing, 1,364,000 cu. fill about structure, 20,000 yds. puddling or tamping backfill, 30,000 cu. yds. concr. in structures, concrete canal lining, and tunnel lining, 3,000,000 lbs. reinf. steel, 170,000 lbs. struc. steel (placing), 33,000 ft. 4-in. to 12-in. drain pipe (laying), with an alternate item of 118,000 sq. yds. Gunite canal lining, were referred to the engineers for report. The low bids

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on the various schedules follow: Schedule No. 1: first six miles of concr. lined canal, south from South Cle Elum: Barnard-Curtis & Co., Minneapolis, Minn., $170,483; Derbon Constr. Co., $183,979; Fisher & Miles, Sacramento, $185,686. Schedule No. 2: six miles concr. lined canal north from Thorp Prairie, three lowest bids as follows: Derbon Constr. Co., 315 Montgomery St., San Francisco and Ellensburg, Wash., $481,004; Strong & McDonald, Tacoma, Wash., $529,768; McHugh & Collucio, Seattle, Wash., $533,647. Schedules 3 to 12, incl., concr. and steel siphons, and two waterways, lowest bidder: E. A. Webster & Co., Hutton Bldg., Spokane, Wash., $309,567. Schedule No. 13: construction of two tunnels: Rumsey & Jordan, Seattle, Wash., $105,302; J. M. Clapp, Seattle, Wash., $142,305; General Construction Co., $148,269.

LOVELOCK, NEV.—Geo. Pollock Co., Forum Bldg., Sacramento, submitted low bid to Lovelock Irrigation District at $610,524 for constructing the Oceana Dam at Lovelock, on the Humboldt River, 1167 ft. long on the crest, and 80 ft. high. The bid was on the dry place, rolled and wet, method of fill, No. (1). Their bid on No. (2) dredge fill, was $621,024. Macdonald & Kahn, San Francisco, bid $919,094 on same type as on No. (1) but taking the bonds of the district as payment in lieu of cash. Other bids on contract No. (1) cash, were: W. A. Bechtel Co., $720,186; Utah Constr. Co., $763,363.

ARCADIA, CALIF.—E. M. Funk, 28 Diamond St., Arcadia, awarded contract by city June 22, at $2073.83 for constructing a concrete reservoir of 250,000 gals. capacity. Other bids: A. A. Alexander, $4427.80; Nead Constr. Co., $4499.86; John Strona, $4985.28; J. C. Butler, $4915.36; W. M. Kupper, $5022.38; Ryan A. Grut, $5441.25; J. L. Aukland, $5149.34; Franklin B. Gridley, $5694.01; H. G. Klusman, $5722.14; Norman F. Barber, $5834; C. A. Larson, $5834.70; Maurice Bramall, $5965.04; Wm. Hess, $5968.60; Proper & Schrubbe, $6597.90.

GRASS VALLEY, CALIF.—W. A. Bechtel, 625 Market St., San Francisco, has been awarded contract by the Nevada Irrigation District, at $34,908.50 for the construction of the Milton diversion dam at Milton. The district took under advvisement the bids of Pacific Tank and Pipe Co., 4820 Santa Fe Ave., Los Angeles, for proposal A, at $67,-441.68 and the Steel Tank and Pipe Co. of Calif., Berkeley, for proposal A at $80,778, which are the bids for the construction of the Milton pipe line from the dam to the north portal of the Milton-Bowman tunnel. Approximate quantities are: CONTRACT No. 19: Construction of Milton Diversion Dam, at Milton, involving: 380 cu. yds. solid rock excavation, 2670 cu. yds. loose excavation, 1700 cu. yds. concrete, also furnish and install a trash rack, outlet pipe, 24-in. slide gate, and air vents. CONTRACT No. 20: Construction of Milton Pipe Line from Milton Diversion Dam to connect at the North Portal with the Milton-Bowman tunnel, as follows: PROPOSAL A—2.2 acres clearing, 3575 cu. yds. solid rock excavation, 2600 cu. yds. loose excavation, 7 M. B. M. lumber in substructures, 3415 lin. ft. 84-in. wood stave pipe (furnish), 2390 lin. ft. wood stave pipe (lay), furnish 84-in. steel pipe manifold connection to the tunnel; PROPOSAL B—1.1 acres clearing, 2670 cu. yds. solid rock excavation, 1670 cu. yds. loose excavation, 5 M. B. M. lumber in substructures, 3440 lin. ft. 88-in. steel pipe (furnish), 2415 lin. ft. steel pipe (lay). F. H. Tibbetts, Alaska Commercial Bldg., San Francisco, engineer.

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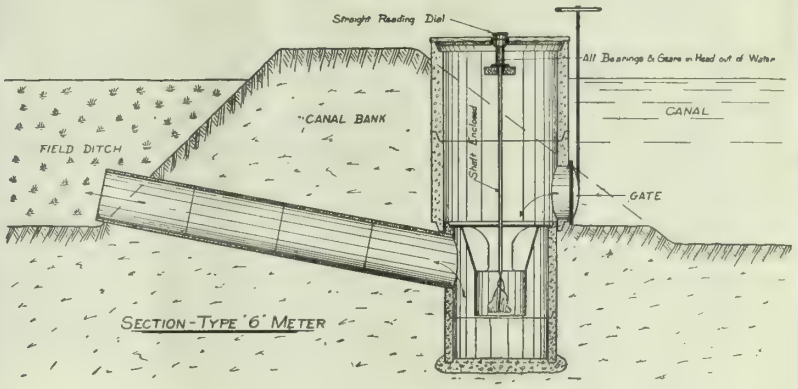

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For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

WHO'S *WHO* AND WHO'S *WHERE*

IN THE WORLD OF HYDRAULICS

Personal Notes and Impersonal Observations About Men You Know

Roy Fowler has been appointed city engineer of Santa Cruz, California, to succeed James K. James, resigned, and Robert S. Tait has been appointed superintendent of the municipal water works.

Governor Frank Emerson and State Engineer John A. Whiting, of Wyoming, have gone to Washington to confer with Secretary of the Interior Hubert Work on the Rock Creek conservation project.

J. W. Williams, for several years consulting engineer with the city attorney's office, San Diego, California, has been appointed assistant city manager in charge of water development, and will rank as hydraulic engineer of the city.

D. A. Abrams, director of the research laboratory of the Portland Cement Association since 1916, has resigned. H. F. Gonnerman succeeds Mr. Abrams as director of the laboratory, and F. R. McMillan, director of research.

Fred A. Noetzli has been appointed by the board of supervisors to act in a consulting capacity on the various dams being constructed by the Los Angeles County Flood Control. Mr. Noetzli is regarded as an authority on arch type dams.

Congressmen R. E. Updyke, Sr., of Indiana, and A. V. Burthess, of North Dakota, made a recent tour of inspection along the Colorado river, accompanied by M. J. Dowd and C. L. Childers, officials of the Imperial irrigation district.

R. C. Rutter, who was resident engineer on the Lake Pleasant dam, Arizona, and before that had charge of the laying out of the Horse Mesa dam for the Salt River Valley Water Users' Association, has been engaged by Harris County, Texas, as construction engineer on the highway improvements to be made in the county under a recent large bond issue.

Robert V. Van Horn, who is a member of the engineering faculty of the University of Washington, has been appointed concrete inspector on the Kittitas High Line canal, Yakima project, Washington, under Division Engineer A. A. Whitmore at Easton.

C. E. Dorisy and Henry L. Gray, consulting engineers of Seattle, Washington, have been engaged to make a survey of the water possibilities in the Hoquiam district, Washington, and an appraisal of the Hoquiam Water Company's holdings, according to a recent report from that city.

F. E. Thompson, formerly manager of the Ochoco Irrigation district, Oregon, and one of the best known men in irrigation circles in the state, has been appointed manager of the Jordan Valley district by the state conservation committee. Mr. Thompson took active charge of affairs the last week in June.

Harry T. Cory, of Los Angeles, as the personal representative of Secretary of the Interior Work, has been making an extensive survey of the Salt River Valley Water Users' Association, Arizona, to make a report thereon to Dr. Elwood Mead, commissioner of reclamation. The investigation was at the request of C. C. Cragin, general superintendent and chief engineer, and of the board of governors of the Salt River project.

Verney W. Russell, who has been named division engineer for all work on division No. 3 of the Kittitas High Line canal, Washington, has moved to South Cle Elum. Mr. Russell has been connected with the reclamation service for more than twenty years, during which time he has worked on the Shoshone dam, Wyoming, the Sun River Slope canal, and was assistant construction engineer on Sherburne Lake dam, Montana, and on Salmon Lake dam, Washington. Before being assigned to the Ellensburg office of the service, Mr. Russell was assistant engineer on the Sun River project, Montana.

J. A. Dunn, who was formerly assistant secretary of the American Concrete Pipe Association and later chief engineer for the Independent Concrete Pipe Company at Indianapolis, has been appointed chief engineer for the American Hume Concrete Pipe Company, the licensees for America of the Australian Hume developments. Mr. Dunn succeeds W. D. Kimmel, who has resigned to take over the management of the Detroit Hume Pipe Company, Michigan licensees for the Hume process. Mr. Kimmel has been with the company since its organization two years ago.

E. C. LaRue has resigned his position with the United States Geological Survey. Mr. LaRue, who is a graduate of the University of California, is recognized as an authority on the Colorado River and its water problems. He has made many exploring and surveying expeditions into the Colorado and its tributaries for the government since he entered the engineering service in 1904. He established survey headquarters in Pasadena, California, in 1917, after several years as district engineer of the United States Geological Survey, with headquarters at Salt Lake City.

Professor Frank Adams, of the Division of Irrigation Investigations and Practice, University of California, is on his way to Palestine where he will serve as adviser to the joint American commission to study the economic, agricultural and industrial development of that country. The commission was formed by the Zionist Organization of America and is under the chairmanship of Dr. Elwood Mead, commissioner of reclamation. Among other expert advisers who have left for Palestine in connection with the work are Knowles Ryerson, agriculturist with the United States government in Porto Rico and formerly with the agricultural extension service of the University of California, and A. T. Strahorn, who for many years has been with the U. S. Bureaus of Soils and Reclamation. It is expected that the work will take from four to six months.

MODERN Irrigation

The Magazine of Applied Hydraulics

CALIFORNIA STATE

Vol. III AUGUST, 1927 No. 8

LOWER OTAY RESERVOIR, SAN DIEGO, CALIFORNIA, WATER SYSTEM

In This Issue—

Nevada Irrigation District Finishes First Large Construction

Administration of Stream Flow In Western Irrigation States

Prosperity of Owens Valley As Revealed by Vital Statistics

Construction Program Shows Size of Mokelumne River Project

—and Articles of Especial Interest to the Waterworks Industry

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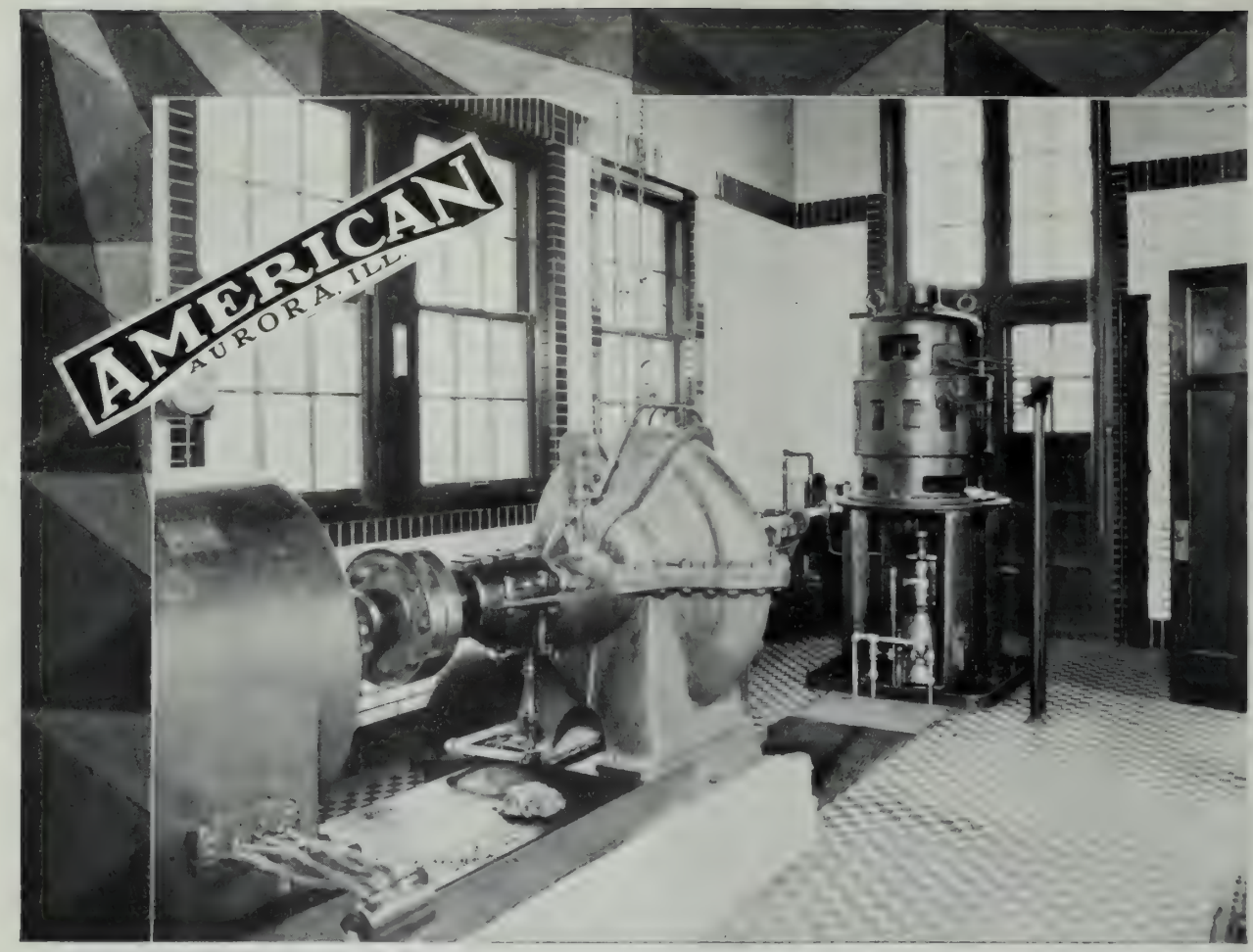
An Organized Voice for the Forces of Agriculture and Industry Which are Primarily Dependent Upon Irrigation



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THERE are four stations upon which Sioux City, Iowa, depends for its municipal water supply.

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Station number one was installed in 1915 and station number four, pictured above, was installed in 1922. All of the four stations are equipped with "American" pumps.

THE AMERICAN WELL WORKS

General Offices AURORA, ILLINOIS *and Factory*

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PETROLEUM WORLD 819 SANTEE ST., LOS ANGELES, CALIF. MODERN IRRIGATION

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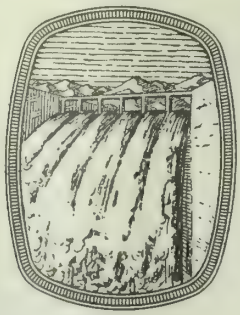
FRED H. TIBBETS

Widely known consulting engineer of San Francisco, California, who has been prominently identified with major projects in various parts of the state. Mr. Tibbets is at present chief engineer of the Nevada Irrigation District, a project of great magnitude and unusual character, which was conceived and became a reality under his administration.

MODERN Irrigation
The Magazine of Applied Hydraulics



Volume III AUGUST, 1927 Number 8

The Progress *of* Irrigation

ONE OF THE outstanding events of recent weeks is the appointment by the Department of the Interior of a board of consulting engineers for the purpose of considering and reporting upon various matters in connection with the design and construction of three large dams planned for early construction or already under way by the Bureau of Reclamation, as follows: Owyhee dam, in Oregon; Deadwood dam, in Idaho; and Gibson dam, in Montana.

The members of this Board are: A. J. Wiley, of Boise, Idaho; D. C. Henny, of Portland, Oregon; and W. H. Nalder, of the Denver office of the Bureau of Reclamation. Associated with these in the consideration of the respective dam sites will be the following: at Owyhee, F. A. Banks, Construction Engineer; at Deadwood, R. J. Newell, Project Superintendent, Boise project; and at Gibson, George O. Sanford, Project Superintendent, Sun River project, and Ralph Lowry, Construction Engineer.

The Owyhee dam is to be located in a canyon section of the Owyhee River about 20 miles above its mouth, and will have a total height from foundation to parapets of 360 feet, making it *11 feet higher than the world's highest existing dam,* namely, Arrowrock, completed by the Bureau of Reclamation in 1915. Owyhee dam will provide a storage capacity of 595,000 acre-feet of water, to be used for the irrigation of 124,000 acres of land, a portion of which is now afforded a partial water supply from the Owyhee and Snake rivers.

The problems to be considered by the engineering board in connection with the Owyhee dam are outlined by Chief Engineer, R. F. Walter, of the Bureau of Reclamation, as follows:

(a) Suitability of the site for a dam of the proposed magnitude in view of the foundation conditions as disclosed by geological reports and drilling and testing at the damsite.

(b) Additional foundation exploration not now definitely contemplated that should be performed before final designs for the dam and related works are prepared.

(c) Best approximate position for the dam, taking into consideration all features including the probable future construction of a plant for the development of electric power.

(d) General type of dam most suitable for the conditions to be met. It is anticipated that a definite recommendation can be made at this time as regards

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the choice between the arch dam and the gravity dam. In the event an arch dam is recommended, further study will be necessary before decision is made regarding the type of arch and this decision can await later consideration by the board members.

(e) Recommended controlling stresses to be permitted in the detailed design of the dam.

(f) Source of concrete aggregates to be used, particularly as to the choice between shipped in and manufactured aggregates, taking into consideration the transportation and construction conditions. Final decision in this matter, especially as to the choice between the sources of shipped in material will be affected by the results of tests not yet completed.

Dr. Warren H. Smith, Geologist, of Eugene, Oregon, has been appointed as a consulting geologist to examine and advise as to the geological conditions disclosed by the recent diamond drilling. It is expected that he will make his examinations of the field conditions immediately in advance of the meeting of the board and it is hoped that he will be present at the time the board meets to give advice.

The Owens Valley district is extremely popular with the summer tourist. *See page twenty-five.*

Deadwood dam is planned to raise the water surface of the Deadwood river, a tributary of the Payette, 113 feet, forming a reservoir with a storage capacity of 101,000 acre-feet, to provide storage for the Black Canyon Division of the Boise project and adjacent lands. Estimates have been prepared for two types of dam, a concrete arch and an earth and rock-fill embankment. The principal duty of the engineering board will be to advise as to the more suitable of these two types.

The points to be considered by the board at this site are outlined as follows:

(a) Availability of suitable sand and gravel for concrete construction. In this the question of the amount of such material that is available is believed to be of great importance. It is estimated that a concrete arch dam of the required height will contain not to exceed 65,000 cubic yards of concrete.

(b) The availability of sufficient suitable material for an earth and rock-fill embankment as an alternative to a concrete masonry dam. It has been estimated that such an embankment would require about 313,000 cubic yards of clay, sand and gravel material and about 140,000 cubic yards of rock-fill material.

(c) Foundation conditions as disclosed by test pits and surface conditions and the effect of these foundation conditions on the type of dam to be built.

(d) Effect of the short construction season and the long haul for construction materials on the type of construction to be adopted.

Gibson dam, contract for the construction of which has been awarded to the Utah Construction Co., will be of the massive concrete arch type with a maximum height of 195 feet and a crest length of 900 feet. It will store 90,000 acre-feet for the irrigation of lands on the Sun River project of the Bureau of Reclamation. Excavation for the base of the dam and the spillway was begun by the contractor in December, 1926, and has progressed to a point where it is desired to start concreting in a short time.

The matters to be given consideration here by the engineering board have to do with the suitability of foundation conditions as now exposed, the extent of additional work to be done on the foundations before concreting is begun, the suitability of the contractor's plant for producing from the available materials uniform concrete of the required strength and durability, and the precautions that must be exercised by the construction engineer to insure the best quality of concrete in the structure. The work that has been done for the foundation grouting is also to be considered and any advisable changes outlined.

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Bowman Dam Completion Marks Beginning of New Era of Agricultural Development

Nevada Irrigation District Completes the First Important Unit of Entire Project After Two Years of Construction

By FRED H. TIBBETTS
Chief Engineer

FOR the past two summers the Nevada Irrigation District has been rushing to completion works for the collection of its water supply in the high Sierras of eastern Nevada County. This work has been carried on in a rugged region of great scenic beauty and historic interest. A half century ago these same mountain canyons were teeming with miners and laborers with pick and shovel, laboriously constructing dams and canals to develop water for placer mining in the mountains to the west. The old dams and canals are now being rebuilt and relocated, much larger and more massive than before, to develop an augmented water supply for farming, for the manufacture of hydro-electric power, for domestic supply, and for the resumption of hydraulic mining.

The outstanding impression which the visitor gets of the construction work is its thorough mechanical equipment, typical of America's greatest contribution to the industrial progress of the age. Power is supplied by high pressure electricity generated at Lake Spaulding, twenty miles away. The old stage road of early days has been rebuilt so that it might be utilized by the great fleet of swift and powerful motor trucks with which materials and men have been brought to the work. The heaviest and most modern construction machinery has been used throughout. In the long canals and tunnels and great dams one sees apparently few men at work, but everywhere there are powerful machines blasting and tearing and re-forming the rock. On the great dam at Bowman Lake, probably the second largest artificial rock pile in the world, the W. A. Bechtel Company, introducing new and ultra-efficient and modern methods, has quarried, loaded and transported the vast pile of rock entirely with machinery, using great steel trucks and steam shovels, capable of handling rocks up to twelve tons in weight.

The opening of the gates at the Bowman Dam on June 30th marked the completion of the first and most important unit of the district's initial water development, and will herald the commencement of a new era of agricultural progress in the foothills of Nevada and Placer counties. For the first time abundant water from the mountains will be brought to the land under the complete direction and control of the land owners.

Divisions of the Project

This whole project falls naturally into two distinct units, separated widely as to purpose and location. The mountain division embraces the water production system, while the district division forms

Erecting metal flume on the Bowman Spaulding conduit. This flume is two and one-half miles in length, and has a diameter of ten feet.

the distribution system. The latter includes the network of canals and laterals throughout the irrigated area, which will convey the water to the individual farms, mines and cities. Its numerous flumes, long buried steel pipe lines, and great variety of miscellaneous structures are in themselves a large project and their importance and value are undoubtedly already appreciated by all who have an interest in the use of water.

The works of the mountain division, however, being distant many miles from the district's boundaries have probably been less completely visualized by the land owners. Lying at an elevation of 5000 feet and well off the usual lines of travel, they can be visited only after expending the time and effort required to make the trip to Bowman Lake. Probably only by actual inspection can the vital nature of the water production system and the magnitude of the work completed, be fully appreciated.

General Plan of Mountain Division

Canyon Creek is the main tributary of the South Yuba River. The Canyon Creek basin is one of the wildest and most rugged portions of the Sierra Nevada Mountains, a region of bare granite cliffs and basins, sparsely wooded. The early miners built several small reservoirs in this basin and two large ones, commonly known as French Lake and Bowman Lake, which have been recently acquired by the Nevada Irrigation District. Bowman Lake is the heart of the mountain division. The old dams of these two reservoirs have been demolished, and by the construction of two new dams a great storage reservoir has been created which will catch and impound the abundant spring stream flow and regulate its delivery to fit the district's needs. It will be supplied by the flow from upper Canyon Creek and its tributaries, in addition to the outflow of numerous small lakes which lie on the upper watershed.

Adjoining Canyon Creek basin on the east and north is the Middle Yuba River, a watershed somewhat larger than Canyon Creek basin. This Middle Yuba River has been brought in back of the Bowman Lake or Canyon Creek watershed and artificially added to it by the construction of a tunnel through the mountain range between the two watersheds, over four miles in length, the most difficult and tedious item of the mountain construction. Thus the great spring runoff from the melting snows of these combined watersheds will be concentrated at Bowman Lake and the regulated outflow from the reservoir will be conveyed through the Bowman-Spaulding Conduit to Lake Spaulding and then by separate routes to the two main delivery points at the boundaries of the district on Bear River and Deer Creek, respectively.

Extremely Heavy Construction

The work in the mountain division under the initial construction program will cost approximately $4,000,000. It includes the largest rockfill dam in California and probably the second largest

"Western Waterworks" Begins on Page 25

The Bowman rock fill dam is one of the largest structures of its kind. It has a maximum height of 170 feet, and contains 316,000 cubic yards of rock. It is faced with reinforced concrete. The reservoir behind this structure has a capacity of 65,000 acre feet.

in the world, being exceeded in height only by the recently completed Dix Dam in Kentucky. It includes two large concrete arch dams, one at Bowman Lake and one in the Middle Yuba River, and two smaller concrete diversion dams, one on Canyon Creek and one on Fall Creek. It includes six tunnels, one of them over four miles in length, probably one of the longest tunnels ever built for the exclusive purpose of water diversion. It includes two miles of metal flume 9½ feet wide, 5075 feet of pipe line, 7 feet in diameter, and 6 miles of open canal. One year and eight months have been consumed in the work thus far completed, which is sufficient to permit actual commencement of operation. Another six to ten months will be required to bring in the increased water supply from the Middle Yuba through the long tunnel.

When, in years to come, more lands are put under irrigation and more water is required, plans are complete for further developing this mountain watershed by the construction of additional storage at Bowman Lake, two storage reservoirs on the Middle Yuba River and the diversion of the North Fork of the Middle Yuba ("Haypress") and two smaller watersheds and the doubling of the capacity of the Bowman-Spaulding conduit at a total additional ultimate cost of about $5,000,000.

Relation to Former Mining Projects

In appraising the accomplishments of the district during the past few years, it is only fair that credit be given to the energy and resourcefulness of the engineers and builders of the days of hydraulic mining. The new rockfill dam at Bowman Lake stands on the site of the old Bowman Dam, which was constructed in 1872 and 1876 to store water for the gravel mines on San Juan Ridge, and no better location and no better type of construction has been disclosed by the studies and surveys made by the district during the last six years. The keystone of this old dam, bearing the date of 1876, has been carefully preserved as the old dam was demolished, and will be found as the supporting, or foundation stone of the inscription or title plate of the new and larger dam. The records of stream flow obtained by the mining companies have been invaluable in the studies which led to the design of the new works. Nowhere in California is there such a reliable and extensive record. Its use has enabled the Nevada Irrigation District to confidently forecast the amounts of water possible to develop from the Bowman region. The preservation of the watersheds for present district use is probably due in no small degree to the continuing existence of the old companies, despite the enforced discontinuance of their operations. Thus, the district in several ways has become the fortunate possessor of a most valuable heritage from the builders of the old mining works, who had such immeasurable difficulties to contend with, as compared with those of the present day.

North Bowman Dam

The first dam at Bowman, constructed in 1872, was a rockfill timber crib about 72 feet high. When raised in 1876 the timber cribbing was covered with the rock dam, familiar to hunters and fishermen in this section for the last fifty years. Because the old timber cribbing was partly decayed and sinking, the old dam had to be entirely turned over to permit the removal of the timber at the bottom. The material in the old dam was washed, as it was moved over with the steam shovels, to form the lower portion of the rear of the new dams. The new structure is a massive rockfill, built of cleanly washed granite from the old dam and from nearby quarries. The quarried rock was blasted out in a few tremendous blasts, loaded by steam shovels into heavy, specially built steel trucks, and dumped into place. The upstream portion, 25 feet wide at the bottom and 6 feet wide at the top, is built up of large selected rocks, forming a rubble masonry wall of a type much in vogue in the construction of medieval castles. This rubble masonry portion of the structure enables the front slope to be made steeper than the loose rock pile on the rear. It also forms a solid backing for the water-tight skin of reinforced concrete on the lake face of the dam.

This concrete slab varies in thickness from a minimum of 12 inches at the bottom to a minimum of 8 inches at the top. It is heavily reinforced with steel rods running both horizontally and vertically, and is provided with copper-filled expansion joints about 48 feet apart, running up the face of the dam, in order that cracks in the concrete might be concentrated where leakage would not result. The upstream face of the dam has a slope for the top 30 feet of ½ horizontal to 1 vertical, and for the balance, of ¾ horizontal to 1 vertical. The downstream slope of the loosely dumped rock is 1 2/5 horizontal to 1 vertical, this being slightly flatter than the natural angle of repose of the material. The crest of the dam is 15 feet wide, 715 feet long, and 167 feet in height above the bed of the stream. The dam contains 316,000 cubic yards of rock, and 8475 square yards of concrete facing. The reservoir covers an area of about 825 acres. Water is released through a tunnel which passes through the solid rock under the south abutment and is controlled by valves at the outlet

The Milton Bowman tunnel, which is four miles long, diverting water from the Middle Yuba River into the Bowman Lake reservoir.

"Western Waterworks" Begins on Page 25

end. The total cost of the completed dam is about $849,000.

South Bowman Dam

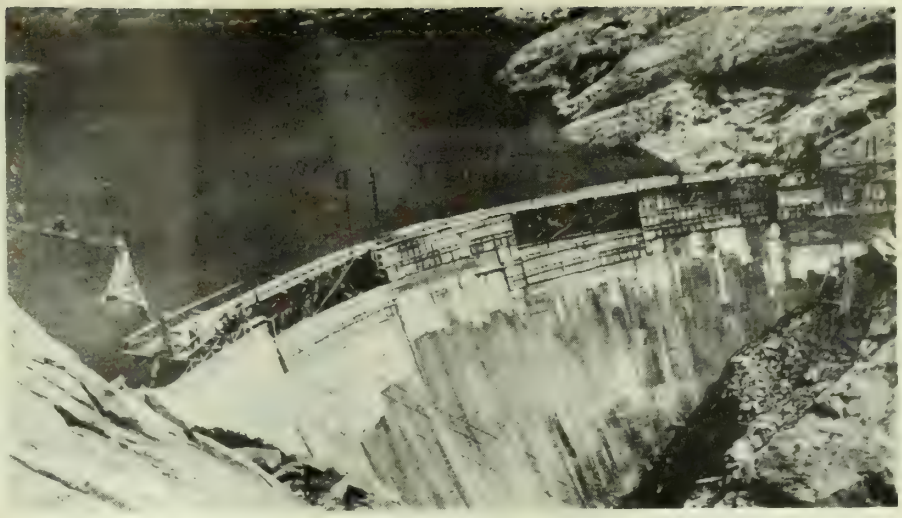
The South Bowman Dam is a concrete arch structure which closes a secondary gap in the rim of the reservoir, and also serves as a spillway. It is 135 feet in height from the bottom of the cutoff wall and 585 feet long, measured at the crest, including the spillway. The arch is 48.6 feet thick at the ground line in the center, and decreases in thickness to 5 feet at the top. It contains a total of 24,750 cubic yards of concrete. The spillway is located at the south end of the dam and will have sufficient capacity to release many times the estimated maximum flood which can reach the outlet of the lake. The total cost of the structure will be about $391,000.

The total cost of the Bowman Lake Reservoir Project including dams, reservoir site, lands, etc., is about $1,677,000 or $25.80 per ac. ft. of storage (65,000 ac. ft.).

Milton Bowman Tunnel

The Milton-Bowman tunnel, which will divert water from the Middle Yuba into Bowman Lake, and which will not be completed until next year, will have a total length of 21,652 feet, or 4.1 miles. It has a width of nine feet and a clear height of 9 feet 9 inches with arched roof. Portions of it where the rock is unstable will be lined with concrete. To divert water into the tunnel, a low concrete dam is being constructed in the Middle Yuba River and the flow will be conducted from the dam to the tunnel portal through a 7-foot wood stave pipe 3415 feet in length. The total cost of the tunnel and diversion works will be approximately $1,344,000.

A portion of the Bowman Spaulding conduit has been excavated from solid rock. The above is a picture typical of this work.



The Bowman south arch dam, nearing completion. This structure has a maximum height of 135 feet.

The Middle Yuba diversion will operate entirely automatically and will not require attendance. Water will be conveyed from the Milton Diversion Dam under cover and immune from interruptions from snow or slides, to Bowman Lake where all regulation will be accomplished.

The Bowman-Spaulding conduit has been constructed to carry the water released from Bowman Lake, to Lake Spaulding, where it mingles with water stored by the Pacific Gas & Electric Company. For the first 13,000 feet the water is carried in a large semi-circular metal flume, supported on a timber substructure which rests on concrete pedestal blocks built into the solid rock cliffs which are the predominant feature of the topography. Below the flume, the water is carried in an open canal interrupted at numerous points by tunnels and special structures. Texas Creek is crossed by means of a flume, while at Fall Creek and Jordan Creek, large wood stave pipe siphons have been constructed. There are four tunnels along the line of the conduit, varying in length from 108 feet to 2925 feet. The total cost of the Bowman-Spaulding conduit will be about $979,000.

Utilization of Water

The mountain division has been designed to deliver 200 cubic feet of water per second or 400 ac. ft. per day (8000 miners inches) to Lake Spaulding, during at least nine months of each year. For the use of this water through their power houses, the Pacific Gas & Electric Company has contracted to pay the district over $400,000 per year and to convey and deliver to the district sufficient water for the irrigation of 40,000 acres of land. The revenue thus received will be sufficient to pay all costs of the mountain division, including maintenance, operation, interest and amortization of the first cost. The officials of the district have accordingly accomplished the seemingly impossible feat of providing the district with a regulated irrigation supply delivered at two conveniently marginal distribution centers and absolutely without any cost to the district.

The distribution of free irrigation water thus provided to the farms, cities and mines within the district will be the function of the district division of the project, which has been well started and will be extended from time to time as the demand for water grows. With the first delivery of water from Bowman Lake on July 1st, the actual operation of the district's project as a whole began. Cheap irrigation water and freedom from taxation at the outset, must emphasize the fact that this is the first irrigation district in which the usual financial hardships of the early development period have been completely eliminated, by the construction of self-supporting water collection and supply elements, with a most substantial financial return to the district from the outset.

Warmsprings Drains Pushed

Good progress is being made on the drainage works under construction in the Warmsprings district, Oregon, by government forces. Two dredges are being worked on a three-shift basis. Eleven miles of canal have been completed, out of a total of about 50 miles to be built in the project. These eleven miles of drains are returning to the river 110 acre feet per day, an extremely heavy flow which indicates the urgent need for drainage in the Warmsprings district. Some of the best farm land in the state is in this district.

"Western Waterworks" Begins on Page 25

Water Codes for Stream Flow Administration Show Great Variance in Western States

Laws Governing Water Distribution Have Been Adopted by All Irrigation States Except Kansas, Montana, and South Dakota

By EDWARD HYATT, Jr.*

Chief of Division of Water Rights, State Department of Public Works, California

THERE are seventeen western states in which irrigation is generally practiced. These include Texas, Oklahoma, Kansas, Nebraska, North and South Dakota and all states west thereof. Of these seventeen states all but Kansas, South Dakota and Montana have adopted water codes providing for state administration of the distribution of the waters of their stream systems through the agency of water masters or water commissioners. While the fourteen codes adopted show considerable variance in nomenclature and in points of procedure an analysis reveals substantially the same underlying purpose in each, which is to make possible effective state control of the distribution of water.

Each code provides for the division of the state into water districts. In Colorado and Texas this division was arbitrarily made by legislative enactment and in all other states the water districts are created as needed by the State Water Commissioner, State Engineer or official in charge of water matters. In three states the water masters are appointed by the governor; in one state the water users elect the water masters and in all others they are appointed by the chief water official. In eleven states the water master has the power of arrest and in ten interference with his acts constitutes a misdemeanor. Twelve of the fourteen codes give the water users the right of appeal from the actions of the water master; seven to the superior, district or circuit court according to the judicial structure of the state and five to the state office in charge. In three states the compensation of water masters is fixed by the legislature, in one by the water users, in one by the county commissioner and in the remaining mine by the state office.

Financing of the work of distribution is accomplished in various ways. In one state, Nebraska, it is paid from general state funds and in five others from general county funds. The California legislature has just passed an act by which the cost will be met half by the state and half by the water users. In the remaining seven states the charges are met in different ways but in each case are later assessed back against the actual water users. The basis of apportionment of cost among the water users is in most cases the respective amounts of water delivered. In one state, Nevada, it is on the basis of the established water rights.

EDWARD HYATT, JR.

Chief of the Division of Water Rights, Department of Public Works, State of California.

According to the 1920 census, the irrigated area in California exceeded that in any other state and was more than double that of any of the states except Colorado and Idaho. With the statutory water codes approximately the same in the irrigation states and with the greatest irrigated area in California, it would naturally be expected that California would be found in the lead, or nearly so, in the matter of efficient handling of its water resources and particularly in the matter of distribution. This, however, is far from being the case. In both adjudication and distribution California is far behind such states as Colorado, Wyoming, Idaho and others. The reasons for this condition are not far to seek. The principal obstacle lies in the recognition by California of the riparian principle.

Riparian Rights

I understand that most of the intermountain states have escaped the riparian rights doctrine and its consequences entirely and if so you probably have no conception of the trouble the recognition of this doctrine has caused and the handicap it has been to California. Years of effort and millions of dollars which should have been put into development have been expended in conflict and litigation. A general uncertainty has been thrown about the legality of water rights which has added greatly to the difficulties in the way of water projects.

To such of you as may not be familiar with this subject I will explain that a riparian right rests upon land ownership and inheres in land which borders upon a stream of water. The right as defined by the California courts does not depend upon use nor cease with disuse, is superior to an appropriative right except in special instances, and is not limited to reasonable use as against the appropriator. It is contrary both in theory and practice to the doctrine of appropriation of water resting entirely upon use, and is of course opposed to any general water conservation measures such as have to be resorted to in the West.

History of California Water Law

California's water law history has been unfortunate but interesting. The appropriative doctrine was established in the "fifties" by the miners as a necessity of the time and has been recognized by the courts from that time on although not until 1913 clearly set forth by statute. The riparian theory was adopted by reference when the common law of England was made the rule of decision in the state by statute of 1850. The two doctrines of water law being contrary in principle naturally led to many disputes and neither being adequately set forth by statute such disputes could be settled only by court decisions. Therefore, in sixty years we have had about seven hundred state supreme and

*Presented at the annual convention of the American Society of Civil Engineers, Denver, Colorado, July 14, 1927.

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Tabulation Summarizing Laws Pertaining To Administration of Stream Systems by Water Masters of States Having Code Provisions for Same As of July 1, 1926

State	Divided into Water Districts By	Water Masters Appointed By	Water Masters Supervised By	Water Master Has Power to Arrest	Penalty for Interference with Regulation of Water Master	Water Users Have Right of Appeal To	Compensation of Water Masters Fixed By	Water Masters Paid By	Funds from Which Water Masters Paid	Method of Collection of Funds	Apportionment of Cost Among Water Users Basis of
1. Arizona	State Water Commissioner	State Water Commissioner	State Water Commissioner	Yes	Misdemeanor	Superior Court	State Water Commissioner	Water Users	Assessments Ordered by Superior Ct. each month	No Provision	Discretionary with Superior Court
2. California	Chief of Division of Water Rights	Chief of Division of Water Rights	Chief of Division of Water Rights	Yes	Misdemeanor	Superior Court	No Provision	No Provision	No Provision	No Provision	No Provision
3. Colorado	Legislature (State has been divided into 70 Water Districts)	Governor	State Engineer (through Division Engineers)	Yes	Misdemeanor	State Engineer (through Division Engineers)	Legislature	County	General County Fund	General County Taxes	Not Apportioned
4. Idaho	Department of Reclamation	Elected by Water Users	Department of Reclamation	Yes	Misdemeanor	Department of Reclamation	Water Users	County	Current County Expense Fund	Special County Taxes against Lands Served	Amount of Water Delivered
5. Nebraska	State Department of Public Works	State Department of Public Works	State Department of Public Works	No Provision	No Provision	No Provision	Legislature	State	General Funds of Department Public Works	General State Taxes	Not Apportioned
6. Nevada	State Engineer	Governor	State Engineer	Yes	Misdemeanor	No Provision	State Engineer	County	County Water District Funds	Special County Taxes against Lands Served	Established Water Rights
7. New Mexico	State Engineer	State Engineer	State Engineer	No Provision	No Provision	State Engineer	State Engineer	County	General County Fund	Special County Taxes against Lands Served	Amount of Water Delivered
8. North Dakota	State Engineer	State Engineer	State Engineer	Yes	Misdemeanor	State Engineer	State Engineer	County	General County Fund	Special County Taxes against Lands Served	Amount of Water Delivered
9. Oklahoma	State Engineer	State Engineer	State Engineer	Yes	Misdemeanor	State Engineer	State Engineer	County	General County Fund	Special County Taxes against Lands Served	Amount of Water Delivered
10. Oregon	State Engineer	State Engineer	State Engineer	Yes	Misdemeanor	Circuit Court	State Engineer	County	General County Fund	General County Taxes	Not Apportioned
11. Texas	Legislature (each Co. constitutes a water district)	State Board of Water Engineers	State Board of Water Engineers	No Provision	No Provision	District Court	County Commissioner	County	General County Fund	General County Taxes	Not Apportioned
12. Utah	State Engineer	State Engineer	State Engineer	Yes	No Provision	District Court	State Engineer	State Engineer	Special Water Master Fund	Assessments against Water Users by State Engineer	Discretionary with State Engineer
13. Washington	State Supervisor of Hydraulics	State Supervisor of Hydraulics	State Supervisor of Hydraulics	Yes	Misdemeanor	Superior Court	State Supervisor of Hydraulics	County	General County Fund	General County Taxes	Not Apportioned
14. Wyoming	State Board of Control	Governor	State Board of Control	Yes	Misdemeanor	Superior Court	Legislature	County	General County Fund	General County Taxes	Not Apportioned

appellate court decisions on water matters. Covering a range of climatic conditions from humid to arid and such a great length of time the decisions are naturally overlapping and conflicting, however they are in the main not subject of change by legislation and to a considerable degree constitute the water law of the state. It is interesting to note at this point that the other irrigation states likewise adopted the common law of England but that the courts of practically all of the semi-arid intermountain states followed the lead of Colorado and abrogated the common law provision on the general ground that it was unsuited to the needs of the state. If the California courts had adopted this same attitude California would have avoided this difficulty.

California Water Code

On account of conflict between the riparian and appropriative factions it was impossible for many years to enact even an appropriative code but this was finally forced through for the initiation of appropriative rights in 1913. In 1917 an adjudication procedure was added and in 1921 the distribution feature. The distribution statute was incomplete in that compensation for water masters was not provided for and it was not until the 1927 session of the California legislature that the distribution procedure was made workable by the addition of a compensation provision. This law will take effect about August 1st.

Adjudication Methods

Under the 1917 amendment two methods of adjudication of water rights were provided—first, a complete procedure for the adjudication of appropriative rights patterned after the Oregon act which was thought to be the best then in existence; the other by authorizing judges of superior courts to transfer water litigation to the Division of Water Rights for investigation as referee. The results under these two modes have not been as anticipated. While the adjudication procedure provided in the act is a complete and admirable one and effective in a case involving only appropriative rights, when our bete noire riparian right enters the picture the situation is changed. This method cannot determine riparian rights; and as any adjudication should, to be satisfactory, take account of all rights it is apparent that this type of action will fail where riparian rights of magnitude exist. To our sorrow we have found that they exist almost everywhere. A good attorney can develop for a client riparian rights which the client himself would never have thought of claiming.

(Continued on Page 48)

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Science Shows that *Constant Concrete* is Possible; *Inundation Method* Turns the Trick

Compensates for the Presence of Water in the Sands in Varying Quantities, as Well as for Bulking Action of the Sand Itself

THE subject of constant concrete is of vital importance, not only to those directly interested in its use, but also to those engaged in the production of each of its component parts. *Constant concrete* may be defined as a concrete the properties of which are so uniform in quality and strength that it may be considered as possessing all of the good attributes of an unvarying material.

It must be generally admitted that concrete made under past and even existing methods has demonstrated a surprising lack of uniformity. No blame can possibly be attached to either specifications or their fulfillment, but responsibility must rest upon lack of practical methods for overcoming variable conditions in the materials of which concrete is made and hitherto uncontrolled variations in the concrete-making process.

In the building of roads alone, the subject of uniform concrete is receiving marked attention. Noting from an article in the February 1925 issue of Public Roads by A. T. Goldbeck, Chief of Division of Tests, Bureau of Public Roads, Washington, D. C., we find the general opinion which is reflected at large by the engineering profession:

"The technical literature of late has placed emphasis on the question of uniformity of concrete. Concrete structures, including highways, are proportioned on the assumption that the concrete has a definite assumed strength. Thousands of concrete cores have been drilled from concrete roads, and the results in many cases show a great lack of uniformity in the concrete, the crushing strength in some cases varying as much as 100 per cent on the same job. Devices are beginning to appear which aim not only to insure more exact measurement of the fine and coarse aggregate, but also of the water used for mixing, which is another of the decided variables which result in lack of uniformity."

Subject of Investigation

In common with so many other important materials, concrete has not escaped rigid and scientific investigation. Such investigations have revealed the fact that *Constant concrete* is possible. In the laboratory, under ideal conditions, where the nature of the ingredients can be carefully investigated and correct proportions determined, concrete can be produced, the strength of which may be forecast to a remarkably close degree. In such laboratory work, the stone and sand are first carefully dried, and in this condition can be accurately measured. In the field, however, it is evident that laboratory conditions cannot be established, and so an equalizing system must be adopted whereby inconsistencies in the aggregate can be automatically overcome, so that not only is the first batch exactly according to specifications, but each succeeding batch is identical.

Some remarkably uniform results have been obtained in the concrete mixes used in the construction of the stadium at the University of Pittsburgh. W. S. Hindman, chief engineer, designed the structure to obtain for some portions 2,000-lb. concrete and for others 2,500-lb. concrete. Herewith is given a table showing the results obtained. In describing these results in "Municipal Improvements," Mr. Hindman writes as follows:

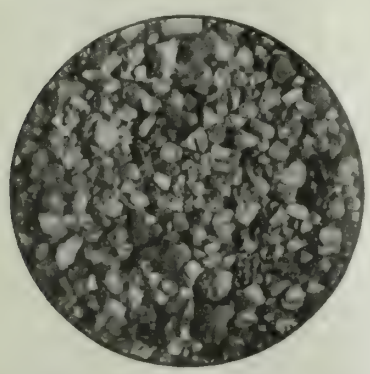
"The mixes indicated in this list are designed according to Abrams' theory, and the actual strengths, as you will observe in most cases, exceed the strengths for which they were designed. Some of this variation I feel sure is due to the storage and temperature conditions under which the cylinders were kept. However, we feel that we have been thoroughly justified in designing our mixes and using the sand inundator to insure uniform proportions and satisfactory strengths to all our concrete placed in the stadium."

Avoid Excess of Water

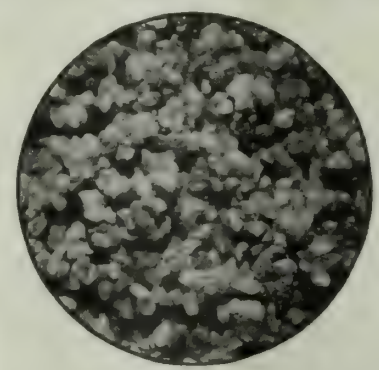
Excess mixing water not only weakens concrete but actually wastes cement. One pint of water more than is necessary in a one-bag batch decreases the strength and resistance to wear as much as though two or three pounds of cement were left out.

When the presence of moisture in almost every sand stock pile is admitted, and common sense dictates that this moisture is present in varying quantities, it is readily seen that without elaborate and constantly repeated tests, it is impossible to determine how much additional water to add to the batch to give exactly the required strength of concrete.

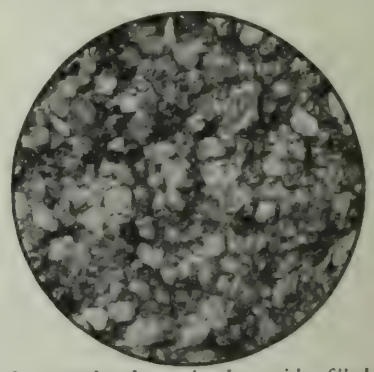
The inundation system, however, compensates for the presence of water in the sand in varying quantities, as well as for the bulking action of the sand itself. This is done automatically and invariably, as it is a simple matter to determine the exact quantity of water necessary to fill the voids in the sand and to



1. Bone dry sand as used in laboratory tests on concrete. Note how sand grains fit closely together. This condition prevails uniformly as long as there is no moisture in the sand.



2. Commercial sand in the moist condition as used on the job. The grains are pushed apart by the moisture. This explains the variable bulking of sand as the moisture content varies.



3. Inundated sand—the voids filled with water. The grains of sand fit closely together like bone dry sand. The space occupied by sand and water is invariable, proving that both volume and water content of inundated sand are constant.

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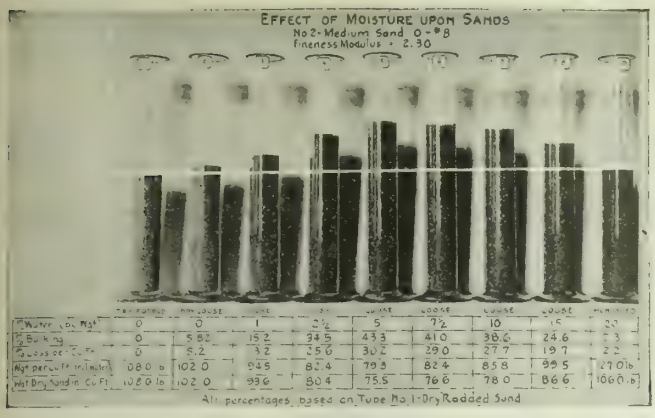

Plate No. 1

All of these tubes contain same absolute amount of sand. Note radical variations in volumes due to moisture.

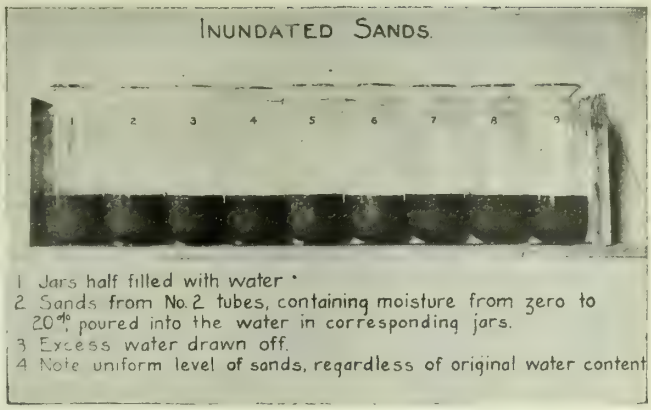
INUNDATED SANDS.
1 Jars half filled with water
2 Sands from No. 2 tubes, containing moisture from zero to 20% poured into the water in corresponding jars.
3 Excess water drawn off.
4 Note uniform level of sands, regardless of original water content

Plate No. 2

This experiment demonstrates how constancy of volume is obtained by Inundation. All of the sand samples from Plate No. 1 have been inundated here.

introduce through an excess water tank connected with the inundator an exact, premeasured quantity of water to complete the batch.

Operation of Inundation System

The inundator itself is made up of: (1) Self-dumping, self-righting, sand measuring container. (2) A water charger. (3) An excess water tank. The operator controls only one main valve.

Open the main water line valve, which fills the charging tank with the exact amount of water needed to inundate the sand. All additional water from this tank flows by means of an overflow pipe into the excess water tank, which has also been set, for the correct amount of water needed to complete the batch. As soon as the operator notices an overflow from the excess water tank, he shuts the valve. Too much water can never be added. A constant quantity is thus always assured. Operator now opens rapid discharge valve from water charger, starts shifting the sand into the inundator and, when full, strikes off by means of the automatic strike-off gate, releases latch, and inundator dumps itself. He then opens valve from excess water tank, and inundation is complete. He operates the stone batcher by opening gate through rack and pinion mechanism, shuts off flow and strikes off automatically. Entire operation takes less than forty-five seconds. It is to be noted that all operations are mechanical.

No Complicated Equipment

As stated above, the inundation system consists of an inundator or self-dumping and righting steel container with an adjustable bottom, a shaker or sand sifter, a strike-off gate, an excess water measuring tank and water storage chamber.

The inundator is mounted on a trunnion arrangement, so designed, that in a single movement, the sand and water for the mix are deposited in the mixer hopper. The specified batch of stone or gravel is placed in the hopper by means of a batcher and the cement is introduced into the batch in the customary manner.

The characteristics of the fine aggregate—*sand*— as received in the field, are such as to make the accurate and consistent measuring of sand and water impossible with the devices used up to the present time, for the reason that the sand is always more or less damp:

First, a varying amount of water is introduced by the sand into the mixer and the total amount of water introduced from batch to batch varies in direct proportion to the amount of moisture held in the sand. This total amount is often sufficient to considerably weaken the concrete unless compensated for.

Second, sand cannot be accurately measured by any device which does not compensate or correct for the bulking or fluffing of the moist sand. This bulking may result in variations of as much as 40 per cent in the absolute amount of sand held in a given volume.

Results of Mixing Concrete by the Inundation Method

Cyl.	Mix	Slump	No. 10 at 28 Days	Average Strength	Designed Strength
T-37	A 1:1.8:3.2	6 "	2,556		
	B		2,407	2,498	2,000
	C		2,532		
T-36	A 1:1.8:3.2	4¾"	2,631		
	B		2,370	2,401	2,500
	C		2,202		
T-35	A 1:1.8:3.2	4¾"	2,581		
	B		2,505	2,512	2,500
	C		2,449		
T-34	A 1:1.8:3.2	6½"	2,977		
	B		2,490	2,736	2,000
	C		2,741		
T-33	A 1:1.8:3.2	6 "	3,042		
	B		2,129	2,732	2,000
	C		3,024		
T-32	A 1:2.3:3.6	5 "	3,093		
	B		2,480	2,683	2,000
	C		2,478		
T-31	A 1:1.8:3.2	5¼"	3,053		
	B		3,941	3,056	2,500
	C		2,174		
T-30	A 1:2.3:3.8	5 "	3,415		
	B		2,769	3,016	2,000
	C		2,865		
T-29	A 1:2.6:3.5	4½"	2,282		
	B		2,664	2,472	2,000
	C		2,469		
T-28	A 1:2.6:3.5	5 "	1,843		
	B		1,913	1,992	2,000
	C		2,221		

Authorities Confirm Phenomenon

The U. S. Bureau of Standards, the U. S. Bureau of Public Roads, and the Structural Material Research Laboratory, Lewis Institute of Chicago, Ill., have all confirmed, after exhaustive scientific tests, this phenomeon of bulking, and its effect on concrete. The two plates illustrated on this page are shown through the courtesy of the Portland Cement Association, and sum up the investigations. It is to be noted from Plate 1 that as the percentage of moisture varies, the bulking of the sand increases up to a certain point. As the water content increases above this peak, the bulking becomes less, until, at a point of saturation, it is found that the volume of wet sand has become practically equal to that of dry. Tubes 1 and 9 have equal volumes of sand; the moisture in Tube 1 is zero, perfectly dry, and the percentage of moisture in Tube 9 is twenty. Plate 2 shows that, independent of the original moisture content of the sand, in all cases when this sand is saturated or inundated, the volume of all of the sands is constant. The nine tubes, with their different bulking and their correspondingly different moisture content, were all inundated, in nine jars, as shown in Plate 2. In every case the volume of sand is the same. Quoting the Concrete Highway Magazine, of February, 1925, discussing these tests, "The result of these tests seems to suggest inundation method of measuring proportions as a means for correcting bulking."

The inundation system not only has been proven desirable in the laboratory, but from actual tests it has been found that constant concrete of a uniformly high strength can be obtained in the field day in and day out from batch to batch.

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The EDITORIAL

MODERN Irrigation

Reg. U. S. Pat. Off.

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Waterworks Convention

DEFINITE word has been received by Paul E. Magerstadt, secretary of the California section of the American Water Works Association, that the national convention of the association for 1928 will be held in San Francisco, probably during the month of July. The many prominent visitors who will attend this convention will be entertained by San Francisco in a manner characteristic of that city and for which it has gained a nation-wide reputation.

The 1927 convention of this association was held in Chicago. Over two thousand people attended this meeting. The registration alone, representing but a portion of the total attendance, totaled over seventeen hundred. While Chicago and the near vicinity supplied a good share of this number, many representatives traveled long distances. Australia, Canada, and Mexico, were represented, as well as forty states of the Union. In view of the fact that California is visited annually by thousands of tourists, it is very probable that the waterworks men will combine pleasure and business and attend next year's meeting in California in even greater numbers.

Probably no other community along the entire Pacific slope can offer more inducements to these visitors at this particular time than can San Francisco. Within a few hours travel from the city there are being constructed some of the largest waterworks projects in the entire West. The East Bay Municipal Utility District is building an aqueduct which is gigantic in size and unusual in design and construction. Sacramento has a filtration plant now in operation which is of extreme interest. The water supply for the city of San Francisco is being carried from the Hetch-Hetchy Valley, and the opportunity to inspect this project alone is well worth the entire trip.

The Engineer and Politics

TO gain the position in business and financial fields to which their profession entitles them, engineers must cease to deal so exclusively with technical problems and must address themselves to the broader phases of industry. The line between business and technical matters should not be drawn so sharply. The engineer has entered the field of management, and the rewards and the respect for his abilities are appearing. He must go further, and deal with the problems in sales, markets, and the financial structure of the industries in which he is engaged, and become a partner, rather than a subordinate in the business.

The engineer should have an important part in the broad study of industry as a whole, as it affects the entire nation, and the world. He should contribute largely to the solution of problems of the equalization of industry; of preventing inflation and depression, for they are complementary; of encouraging development in lines in which competent investigation shows it will be rewarded; of retarding those lines which show a tendency to excessive development. This can best be done by a thorough analysis of the factors entering into the problem and publishing the results to the world. The profession should resolve itself into a fact finding and publishing organization in all matters pertaining to each industry with which it is associated.

Along with this, the profession through its individual members and through the cooperative efforts of its organizations must take part in civic affairs, for government has great influence upon business and industry. The engineer, individually, must do his full political duty, must bear the onus of standing for office, must enter the political contest as the members of other professions do, and must give freely of his time and special knowledge in the public interest. When the importance of the matter to industry or to the public welfare warrants, the whole weight of the organized profession should be employed to secure wise administrative or legislative action.

Owens Valley Disaster

OWENS Valley, which has been prominently before the public eye because of difficulties with the city of Los Angeles over the Owens River water rights, has been visited by a very real disaster whose full extent is not realized by those

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POINT *Of* VIEW

unfamiliar with the situation.

The simultaneous failure of five banks in any sparsely settled community must of necessity create financial distress, but when those banks are the only ones accessible, when they are in entire control of the community's finances, and their deposits represent virtually all the money available, their failure paralyzes the business of the community. That is the situation today in Owens Valley.

Picture a valley, six to twelve miles in width and stretching in length for some 120 miles, shut in on the west by the Sierra Nevadas and on the east by the Inyo range. The passes giving access to points in the San Joaquin Valley and the San Francisco Bay region are at an elevation of approximately 10,000 feet. Thus located, the small towns in the valley are inter-dependent and are largely withdrawn from contact with the world outside.

The deposits in the five Watterson banks at Bishop, Lone Pine, Big Pine and Independence, amounting to approximately $2,000,000, represented practically all the money in the valley. So long as it remained in free circulation it was sufficient for the needs of the community, but when without any warning these five banks closed their doors and the circulation of money stopped, the business of the valley was at a standstill.

The present need in Owens Valley is Los Angeles' opportunity—an opportunity to show its friendship for the smaller community.

There has been misunderstanding and resulting hard feeling between the two communities, it is true, but there is no need for them to continue. The trouble between Owens Valley and Los Angeles has been fomented by a few people on both sides who, for their own purposes, have striven to fan the flame of misunderstanding into active hatred. They have endeavored to spread the belief on the one hand that the city of Los Angeles is a soulless monster seeking to crush out the life of the valley for its own gain, and on the other hand that the citizens of Owens Valley are a lawless band of dynamiters. Both sides are largely wrong. The bulk of the people of Los Angeles desire the prosperity and well-being of Owens Valley, and the very great majority of the valley's residents are industrious, law-abiding citizens.

It is time to clear away the misunderstanding between the two communities—and the present emergency offers an opportunity that should be grasped.

Co-Operation Pays Dividends

THE opening of the Bowman Dam is an achievement which engineers and operators of the Nevada Irrigation District have been striving toward for several years. It is an illustration of the fact that the present age is one of co-operation and co-ordination. Individuals have realized that a union of energy and forces will produce vastly greater constructive results than the petty labors of a minute portion of that union. The effect of such a combination has been well illustrated by Thomas Ingram, a member of the California State Legislature, in a recent talk upon the Nevada Irrigation District.

"The era of coordination and co-operation between industry and agriculture was originally suggested in the agreement entered into between Nevada Irrigation District and the Pacific Gas and Electric Company for the use of the storage waters of the District to be utilized for the development of hydro-electric energy and at the same time serve the land owners of the District for irrigation purposes.

"By this equitable agreement, the land-owners get the full use of their water for agricultural purposes and the water also serving in the double capacity of creating power and the earnings from the power reduce almost entirely the cost of the operation of the irrigation district and will ultimately remove the cost to the owners of the land of water charges.

"That this plan is feasible and practical is evidenced by the experience of the Oakdale and South San Joaquin Irrigation Districts of the San Joaquin Valley, which emulated the example of Nevada Irrigation District and entered into a contract with the Pacific Gas and Electric Company to utilize the storage waters of the districts for power purposes and agreed to make the payments over a period of forty years, which will pay the interest and retire the bonds contracted by the irrigation districts. The operation of the Melones power house on the Stanislaus River is the practical and concrete example of this new and recent plan of co-operative financing.

"The irrigation districts mentioned utilized their credit to the extent of $2,200,000 and erected the Melones Dam to store 112,500 acre feet of water and the Pacific Gas and Electric Company expended $2,500,000 in the erection of the Melones power house and agrees to pay the districts $5,175,000 for the use of the water stored in the Melones Dam, the payments to be made over a period of forty years, after which the reservoir is operated jointly by all parties.

"The agreement also provides that the irrigation districts are to have first call on the water during certain necessary months for irrigation purposes as a first preference, the control of the water being in the hands of the districts and the flow of the river being in their control from March 1 to November 1 each year.

"The beneficial use of water is certainly maintained in such an agreement and results in prosperity to all parties in agriculture and industry.

"The plan which originated with the moving spirits of Nevada Irrigation District promises to become notable and nation-wide in the scope of its operations. The Nevada Irrigation District will begin to profit and benefit by the operation of this co-operative plan, and it is no small honor that it was able to point the way whereby other similar organizations can ease the financial burden by the use of their power resources.

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Modern Concrete Pipe Industry Result of Many Years Study and Experimentation

Improved Methods of Manufacture Have Created Product That is Accepted by Leading Engineers for General Usage

By SAMUEL FORTIER*

NEARLY five years ago, I had the privilege of addressing this association at your semi-annual meeting in San Jose, and on that occasion I am credited with saying, "It is not far from the truth to state that 95 per cent of the pipe made by this association is sold to farmers to improve their irrigation systems. In any event your success depends on that of the farmer who uses water in irrigation. Whenever his profits are large a part of the surplus earnings is likely to go into betterments and in these you are reasonably certain to have an interest. There will be lean years in the future as in the past when the meagre profits of the farm will not warrant much outlay in the way of saving labor and water by the installation of more convenient farm systems of irrigation, and when these periods occur you will find the demand for pipe falling off and a corresponding shrinkage in your business. In view of these recurring periods of depression, there is all the more need of a looking forward and a planning for the future in order that you may serve interests other than those which pertain to agriculture. You incur some risk in carrying all your eggs in one basket."

You seem to have profited by that advice by extending the use of concrete pipe and its accessories to municipalities as well as to rural communities. In recent years, demonstration has followed demonstration pointing to the conclusion that the same materials which are used to make a safe conduit for the passage of well water to an orchard can likewise be made into a safe conduit for the removal of waste water from city kitchens. It seems to me extremely important that as many as can among your number modify and equip your plants in such a way that you will be prepared to serve these two classes of clients—those who live on farms and those who live in cities. It is needless to remind you that so great an extension of your field of operations cannot be won without wise planning and long-continued effort.

The privilege of serving municipalities is not going to be handed to you on a silver platter. You will have to fight for every inch of progress made. I believe, however, that the experience gained during the past few years in gaining the farmers' confidence and trade will be of value in winning like favors from the city dweller. Lest you are inclined to forget or minimize the experience gained since 1918, let me recall to your memories a few of its salient features.

SAMUEL FORTIER

Senior Irrigation Engineer, Division of Agricultural Engineering, Bureau of Public Roads, U. S. Department of Agriculture.

At that time concrete pipe or cement pipe industry as it was frequently termed was not on a sound basis or in a flourishing condition. A lot of good pipe had been made long before that date which was giving excellent service, but there was also a lot of inferior pipe which added yearly to the crop of failures and these failures produced a very bad effect on the conservative profession of engineers. I talked with many prominent hydraulic irrigation and sanitary engineers and it seemed to be the general opinion as late as 1920 that unreinforced concrete pipe could not be safely trusted to withstand with safety more than 10 or 15 feet head. They were afraid to recommend it and were not at all squeamish in saying so. I was then in charge of irrigation investigations for the U. S. Department of Agriculture and concluded that our division might do something to place this industry on a sounder basis. Candor compels me to state that we were not so much concerned over your welfare or profits as that of the prosperity of the Pacific Coast states. We had a two-fold purpose in mind: to select materials and make a pipe in such a way that the tensile strength of concrete would be fully utilized, and to test the products by methods that would appeal to the engineering profession and establish confidence in its membership.

I had on the force at that time two young men whom I had trained for years to lay out and construct farm systems of irrigation in the West as well as the East. They were familiar with all kinds of piping and appliances. I had also a third young man who had spent years in assisting our Mr. Scobey to measure the flow of water in pipes. I refer to Milo B. Williams, Fred W. Stanley and Ernest C. Fortier. These three were assigned to this job and in the course of time results began to appear.

Modern Concrete Pipe Result of Experiment

It was extremely difficult to make a beginning, since there was little data available. It was pioneer work from the start. Although concrete had been studied by a large number of technical and scientific men for a score or more of years, very little of the results of such studies applied to concrete pipe. Suitable apparatus for making and testing pipe had to be devised, suitable mixtures adopted, a comparison made between different processes of manufacture and standards, and specifications adopted to serve as guides to the makers and to insure a certain measure of guarantee to the user. The investigation continued through 1918, 1919 and until April, 1920, when our funds gave out and Mr. Stanley was taken over by the California

(*Continued on Page 45*)

*Presented at the joint meetings of the Western Irrigation Equipment Association, the California Concrete Pipe Manufacturers' Association, and the Northwest Concrete Pipe Manufacturers' Association, held in San Francisco, California, July 15, 1927.

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MUD?

The "Caterpillar" *likes* it!

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Concrete Pipe and Equipment Men Hold Joint Meeting

W.I.E.A. Sponsors San Jose Convention in Co-operation with Pacific Coast Pipe Concrete Manufacturers

The recent quarterly convention of the Western Irrigation Equipment Association, held in San Francisco on July 15, in conjunction with the California Associated Concrete Pipe Manufacturers and the Northwest Concrete Pipe Manufacturers, is reported one of the most successful yet held by the association.

The morning was given over to a meeting of the executive committee. It was decided at this meeting to have small folders printed for distribution at the State Fair and at the Fresno County Fair, advertising the W.I.E.A.

The afternoon meeting, held in the roof garden of the Hotel Whitcomb, was a joint meeting of the three associations and was devoted to addresses by Paul Bailey, California State Engineer, Dr. Samuel Fortier, Senior Irrigation Engineer, U. S. Department of Agriculture, and M. Loving, secretary of the National Concrete Pipe Association. Mr. Bailey discussed the water situation as it exists in the various sections of California and explained the work of his department toward the solution of the problems presented. He said, in part, that in the last forty years the area of irrigated land in California has stood at approximately 12,000,000 acres but that the value of products has increased about ten times. This has been due to more intensive cultivation and improved methods.

The first step of the state engineer's office, Mr. Bailey said, has been to conduct an exhaustive survey of available water supply. It was found that about three-fourths of the available supply is located north of Sacramento, while roughly three-fourths of the need is south of Sacramento. The engineer's office is now engaged in a study of the best methods of developing and distributing the water available. Mr. Bailey then exhibited a large map of the state on which were shown the physical features of the plans for water development which he presented to the recent state legislature. The co-ordinated plan as outlined by Mr. Bailey will include provision for the needs of agriculture, navigation, flood control, power supply, and salt water control. Two hundred thousand acres in the delta region have been threatened by salt water seepage which has been observed fifteen miles above the mouth of the Sacramento-San Joaquin rivers.

Professor Fortier was the second speaker of the afternoon. His address is published in this issue of MODERN IRRIGATION. The final speaker was M. Loving, secretary of the National Concrete Pipe Association. His discussion of the construction, testing and handling of concrete pipe was illustrated by lantern slides.

The evening banquet was a joint meeting of the three associations with about 175 present. There were no speeches save those by the master of ceremonies, A. M. "Jack" Frost, of Fresno. After a very interesting program arranged by Don Ray, of the Pacific Gas and Electric Corporation, and the other members of the arrangement committee, there was dancing until midnight.

Border-Furrow Method of Irrigation Presents New Features

Desired Penetration on Agricultural Lands Having Extreme Slope Can Be Obtained By This Method

The method of irrigation to use depends upon several factors such as the type of soil, slope of the land, and kind of crop to be grown. The methods most commonly used at the present time are the wild flooding, border flooding, basin, furrow, and corrugation. Each of these methods through long and varied use in different irrigated sections has undergone many changes and modifications in order that it could be adapted to the given conditions.

In some sections where the land possesses an extreme slope or where the land is very impervious in spots, most of the above methods may prove inadequate in securing an even distribution of soil moisture. The "spotted" impervious condition exists in some parts of the irrigated sections and may vary in size from a few feet in diameter to several hundred feet.

These areas always present a serious problems to the farmer, because the water may pass over them without penetrating the soil more than a few inches in depth. Consequently the moisture in the surface few inches evaporates in a very short time and the plants begin to suffer because of insufficient available moisture. At the present time there appears to be no satisfactory system of irrigating a soil of this type to secure the desirable penetration of moisture. However, a method of irrigating is being tried, called the "Border-Furrow Methow of Irrigation," which appears to have its merits concerning the solving of the above problem; and it can possibly be developed to such an extent that in time it will become a valuable asset to the irrigation farmer.

This method can be used on smooth fields of any practical slope and is a combination of the border and furrow methods. It also has some of the merits of the basin method. The Border-Furrow method, like the strictly furrow method, should be used only for row crops; as it leaves the field in such rough condition that the use of a mower and some other field implements that are used in the production and harvesting of hay and small grains is made very difficult if not impossible.

This system requires that the head ditch be placed almost on a contour line or level, with only sufficient slope to carry the desired quantity of water; however, it can be placed in any way except at or nearly at right angles to the contour lines. The furrows should be run as nearly on the contour lines as possible, so each one will be level or nearly level at all points. These furrows can be extended for the full length or width of the field and can be made with an ordinary lister or middle buster about 8 to 10 inches deep, and 24 to 48 inches apart.

Cross borders running at about right angles to the furrows should be placed at intervals of approximately 400 feet, depending on the size of head of water to be used on each land, or the space between the borders, and the length of the borders. Small heads of water should be used on fields possessing an extreme slope, because of the difficulty in handling the water and the possibility of soil erosion; but on fields that are nearly level it is possible to handle a 5-second-foot head of water on lands 40 feet in width with very little trouble.

The depth of water penetration can be largely controlled by the size of head of water being used, the length of the lands, the depth of the furrows, and the distance between the borders. These factors control the time required for the water to cover the field. All other factors being equal, the longer the period of time the water remains on the field the greater will be the moisture penetration.

The merits of this system are probably more evident when it is used on impervious soils, steep slopes, or short runs. As each furrow is filled the water should pass over the top in several places at the same time, thus avoiding washing; in this way filling the next one below, and so on until the entire field has been covered. After the water has been shut off, each furrow should remain nearly filled with water and not drain to the lower end of the field, as it does when some other methods are used in sloping land. Each furrow should form a separate and distinct basin, thus causing the water to penetrate the soil immediately below and around the furrow. This will greatly assist in securing the desired uniform penetration.

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WESTERN Waterworks
Supplement to Modern Irrigation
Of Interest Expressly to Waterworks Executives, Contractors, and Municipal Engineers

Prosperous Condition of Owens Valley District Revealed by Many Vital Statistics

An Agricultural Community Changes its Business and is Rapidly Becoming Summer Playground of Entire West

By GRAYDON OLIVER

THE controversy between the City of Los Angeles and the citizens of Owens Valley, Inyo County, California, has again been attracting widespread attention. Being a big city, that needs and secures large quantities of water, has certain penalties attached. Los Angeles has paid out about $15,000,000 for lands and water rights in the Owens River Basin, but property holders of the valley seek reparations amounting to another $7,000,000, such reparation claims being based upon assumed destruction of business due to decrease of agricultural development in the valley and an alleged corresponding decrease in population.

Within the past few weeks, five banks of the Owens Valley have closed their doors, leaving Bishop, Big Pine, Independence, and Lone Pine without banking facilities. These five institutions are under the direction of virtually the same board of directors, and have practically identical ownership. The largest of these are the First National Bank of Bishop and the Inyo County Bank. The valley bankers declared that the City of Los Angeles is responsible for the closing, a declaration which Los Angeles promptly denied, asserting in turn that it has spent millions of dollars in Inyo County, and that all expenditures have been cleared through the local valley banks. The operators of these Owens Valley banks have been very active in their campaign against the City of Los Angeles, and upon the morning that the banks were closed, they posted notices upon their doors which read as follows:

"We find it necessary to close all of our banks in Owens Valley. This result has been brought about by the last four years of destructive work carried on by the City of Los Angeles."

Mt. Williamson, as seen from Independence, Inyo County, California.

The Owens Valley lies between the easterly base of the Sierra Nevada mountains and the Inyo Range. The valley is about 120 miles in length, ranges from 6 to 12 miles in width, and lies at an elevation of between 3500 and 6500 feet. It is situated partly in Inyo and partly in Mono counties, and is approximately in the central portion of California, north and

south, on the desert side of the range. It is isolated from the San Joaquin Valley and San Francisco Bay points by the high Sierras, the passes across which are approximately 10,000 feet elevation. The Mojave Desert and the Coast Range intervene between it and Southern California.

The waters of the Owens River rise on the high peaks of the Sierra Nevadas. There are more than 40 crests that attain an elevation of over 13,000 feet along the westerly side of this basin, the highest of which is Mt. Whitney, with an altitude of 14,501 feet—the highest peak in the United States proper. These waters drain into Owens Lake, which has an elevation of 3567 feet, an area of 100 square miles, and no outlet. It is consequently saline. The rainfall on the floor of the valley is but 5 inches, and the total area of the basin tributary to the lake is 2,810 square miles. The evaporation losses from this lake are as great as the amount of water which the City of Los Angeles diverts into the aqueduct.

The floor of the drainage basin of Owens River, north of Bishop, is composed, to a great extent, of volcanic ash and volcanic and tufaceous rocks, all of which are absorbent of water and which tend to regulate the outflow. In addition the canyons that have been carved out of the granite face of the Sierra have discharged great gravel cones, which are also absorbent of surface waters and which liberate them through their outlets in a regulated flow. This has a marked effect on the regimen of the main river.

Los Angeles Purchases Water Rights

The lands and canals purchased by the City of Los Angeles in Owens Valley were bought for the purpose of controlling the riparian rights on the Owens River, thus protecting the city against legal injunctions or adverse diversions, and, in many instances, for the direct purpose of obtaining the water rights of small streams, ditches, and springs. The farm lands were also bought with the idea of controlling the artesian waters of the valley. These waters will continue to be used for irrigation in the Owens Valley until they are required by the city, and the city is leasing this land for farming purposes and permitting this irrigation use.

The citizens of Owens Valley have known for a great many years the effect that the taking of the water from the valley by the City of Los Angeles would have upon business and constructive development. When the plans for the aqueduct were being formulated there was a great deal of opposition to the project from several different organized bodies; and, at that time, conditions were investigated thoroughly. As a conclusion to many conferences that were held at the White House in Washington, President Roosevelt dictated a memorandum covering the outline of the conferences, which reviewed the situation as it existed at that time. The President's letter is as follows:

The White House,
Washington, June 25, 1906

"Messrs. Walcott and Pinchot state that there is no objection to permitting Los Angeles to use the water for irrigation purposes so far as there is a surplusage after the City's drinking, washing, fire, and other needs have been met. They feel that no monopoly in an offensive sense is created by municipal ownership of the water as obtained under this bill, and that, as a matter of fact, to attempt to deprive the City of Los Angeles of the right to use the water for irrigation would mean that for many years no use whatever could be made by it of the surplus water beyond that required for drinking and similar purposes.

"I am impressed by the fact that the chief opposition to this bill, aside from the opposition of the few settlers in Owens Valley (whose interest is genuine, but whose interest must unfortunately be disregarded in view of the infinitely greater interests to be served by putting the water in Los Angeles), comes from certain private power companies whose object evidently is for their own pecuniary interests to prevent the municipality from furnishing its own water. The people at the head of these power companies are doubtless respectable citizens, and if there is no law they have the right to seek their own pecuniary advantage in securing the control of this necessary of life for the City. Nevertheless, their opposition seems to me to afford one of the strongest arguments for passing the law, inasmuch as it ought not to be within the power of private individuals to control such a necessary of life as against the municipality itself.

"Under the circumstances, I decide in accordance with the recommendations of the Director of the Geological Survey and the Chief of the Forestry Service, that the bill be approved, with the prohibition against the use of the water by municipality for irrigation struck out. I request, however, that there be put in the bill a prohibition against the City of Los Angeles ever selling or letting to any corporation or individual except a municipality, the right for that corporation or the individual itself to sell or sublet the water given to it or him by the City for irrigation purposes.

Sincerely yours,
Theodore Roosevelt."

"P. S.—Having read the above aloud, I now find that everybody agrees to it,—you, Mr. Secretary, as well as Senator Flint, Director Walcott and Mr. Pinchot, and therefore I submit it with a far more satisfied heart then when I started to dictate this letter."

Aqueduct Construction Brings Prosperity

There is no doubt that the City of Los Angeles has performed an enormous amount of constructive development in Owens Valley, and that an increase in land values was brought about by this development. For many years previous to the construction of the aqueduct, the business of Owens Valley consisted mainly of diversified agriculture. The residents traded among themselves, and managed to eke out a rather self-sufficient existence. In later years, after the mining operations in western Nevada became a factor, a narrow gauge railroad was built from these mines into the Owens Valley, and the farmers commenced the shipping of their produce to the mines. In the beginning, these mines were operated by a group of independent operators and promoters, who were not careful about their expenditures, and as a result, the Owens Valley farmers received unusually high prices for their produce. These mines were eventually taken over by larger interests, who concentrated their buying power, and were able to obtain foodstuffs and farm products from other sources at much lower prices. This caused an extreme business depression in the valley, which was relieved only by the business received during the construction of the aqueduct. This rather large amount of construction brought considerable new money into the valley which created a period of prosperity.

It was through the agency of the City of Los Angeles that the existing broad gauge railroad was built, as the valley area and developments therein would not have warranted a rail connection into this territory for many years in the future. The construction of this railroad made it possible for the farmers of the valley to ship their produce to ready markets, which would have been impossible otherwise.

Statistics show that Inyo County is prosperous, and that there is probably more constructive development at the present time than at any previous period. In the accompanying tables are given a few of these vital statistics, the most interesting of which are probably the increasing values of real estate, and the rather unusual increase in motor vehicle registration.

The values of property throughout Inyo County have shown a definite increase during the past eleven years. From the table listed on this page, it can be seen that, while the number of acres assessed has decreased, the value of such real estate has increased nearly fifty per cent.

Barometers of Wealth

One of the best barometers of wealth and buying power of a community is its purchase of automobiles. The yearly registrations in Inyo County, which of course is practically the Owens Valley, are interesting. The 1926 registration shows an increase of four hundred and thirty-five per cent over the registrations of 1921, the figures being four hundred seven and seventy-six respectively. With the exception of the year 1923 the increase over the last six years has been gradual. As you are aware, the year

INYO COUNTY REGISTRATION—AUTOMOBILES AND TRUCKS

	1921	1922	1923	1924	1925	1926
Total Registration	1,313	1,493	1,742	2,011	2,370	2,646
Increase in number over previous year		180	249	269	359	276
Per cent increase over previous year		13.709	14.294	15.44	17.85	11.22

All automobiles and trucks belonging to the City of Los Angeles are registered in Los Angeles County.

COMPOSITE FINANCIAL STATEMENT OF ALL BANKS, INYO COUNTY

	1922	1923	1924	1925	1926
Loans and Discounts	$1,898,497.79	$1,934,730.20	$2,073,573.41	$2,086,722.29	$2,103,167.72
Cash and Exchange	288,282.80	295,911.61	511,066.79	326,443.60	353,120.60
Surplus and Undivided Profits	94,849.73	100,947.89	91,386.68	102,006.03	134,960.39
Deposits	1,931,714.12	2,127,884.30	2,453,895.33	2,212,706.28	2,291,138.46
Total Resources	2,434,365.85	2,568,207.19	2,866,343.24	2,677,712.31	2,710,433.85

PROPERTY VALUES, IMPROVEMENTS, AND TAX RATE OF INYO COUNTY

Year	Number of Acres of Land Assessed	Value of Real Estate	Value of Improvements on Real Estate	Grand Total of All Property	Total County Rate of Taxation on each $100 (No State Rate) Inside	Outside
1915	287,500	$5,319,050	$1,183,640	$12,146,953	1.30	1.60
1916	275,436	5,418,561	1,200,140	12,414,328	1.30	1.60
1917	274,619	6,624,550	1,306,555	14,233,093	1.30	1.60
1918	258,258	6,275,921	1,792,352	14,706,995	1.30	1.60
1919	254,661	6,187,731	1,859,783	14,814,745	1.40	1.70
1920	257,360	6,594,397	1,987,644	15,604,943	1.70	2.00
1921	262,813	6,605,452	2,094,351	17,033,180	1.46	1.80
1922	269,411	6,655,692	2,176,631	18,157,579	1.66	2.00
1923	270,368	6,954,814	2,331,055	18,109,750	1.60	1.95
1924	270,963	7,011,250	2,634,055	18,690,398	1.40	1.80
1925	273,606	7,154,633	2,741,794	18,730,553	1.60	2.00
1926	278,914	7,282,380	2,769,207	18,760,737	1.50	1.90

INYO COUNTY REGISTRATION BY CERTAIN PRECINCT GROUPS

Precincts	1916	1918	1920	1922	1924	1926
Round Valley—Hillside West Bishop—Laws North Bishop—Bishop No. 1 Bishop No. 2—Bishop No. 3 Sunland—Warm Springs Poleta	1027	1390	1276	1784	1245	1451
Big Pine No. 1—Big Pine No. 2—Fish Springs	255	419	393	454	279	372
Aberdeen—Independence No. 1—Independence No. 2	220	249	252	360	244	338
Manzanar—George's Creek	72	85	74	94	80	43
Owenyo—Lone Pine No. 1 Lone Pine No. 2	192	267	227	336	322	410
Totals	1766	2410	2222	3028	2170	2614

INYO COUNTY GRADE SCHOOLS
ATTENDANCE AND TEACHERS

	1906	1911	1916	1923	1924	1925	1926	1927
Attendance	618	554	745	887	852	873	798	868
Teachers	21	26	34	44	43	43	39	40
			BISHOP ONLY					
Attendance	131	140	178	229	234	257	206	257
Teachers	3	4	6	7	7	8	6	9

1923 was an abnormally good one throughout the entire country, especially for automobiles. There has never been a bigger year before or since. The 1923 Inyo County registrations were two and one-half times as large as those of 1922. There is probably not another county in California that will show an increase over 1923, but 1926 in that county does show a ten per cent increase over 1923.

It is indeed hard to reconcile these figures with the statement that businesses in Owens Valley are going into bankruptcy, and that people are moving out of the valley by the hundreds and thousands. On the other hand it can be seen from the tables showing registration by precincts in Inyo County, that there

WHOLESALE GROCERY SALES IN LAWS, BIG PINE AND BISHOP COMBINED, BASED ON SALES OF THREE WHOLESALE GROCERIES.

Year	
1921	$33,990.00
1922	47,886.00
1923	49,580.00
1924	45,073.00
1925	
January	$ 2,897.00
February	3,254.00
March	4,493.00
April	3,572.00
May	6,138.00
June	5,497.00
July	8,057.00
August	3,917.00
September	5,937.00
October	5,022.00
November	2,973.00
Total	$55,379.00
1926	
January	$ 3,370.00
February	3,153.00
March	4,546.00
April	5,744.00
May	4,919.00
June	6,741.00
July	6,104.00
August	5,311.00
September	4,647.00
Total	$44,535.00

October, November and December, 1926, are not shown.

is a very healthy and steady growth in population. This fact is also reflected in the table showing the increasing attendance at the public schools of the district. It will be noticed that previous to the construction of the aqueduct, there was an actual falling off in the school attendance, that is between the years 1906 and 1911. From the year 1916, to the present year, there has been a normal increase.

Mineral production of Inyo County has been practically steady since 1922. The values received for these same minerals were higher during the years 1920 and 1921, because of the increased prices

(Continued on Page 44)

Outline of Construction Features Shows East Bay Project One of Great Magnitude

Rapid Settlement of Legal Difficulties by Courts Permits Project to be Developed According to Original Schedule

DURING the past two and one-half years the work of the East Bay Municipal Utility District has forged steadily forward, despite the many difficulties that have been encountered. It will be remembered, that when the Los Angeles Aqueduct was under course of construction, there were incidents that had to be settled in the courts before actual construction took place. In like manner, the East Bay project is beset with a myriad of legal problems, which the courts have been grinding upon since the conception of the district.

Certain lands catalogued as the Kieffer lands have been the latest subject of controversy, and a law suit involving some $22,000,000 was fought in the courts during April to July. The judgment of the court was that lands which were valued by the owners at $2,134.35 per acre, were settled at $46.45 per acre, or about one-forty-sixth of the asking price.

Opponents of the East Bay Municipal Utility District have been, from the very beginning, very industrious in their attempts to defeat the project. Four years ago, when the district was being formed, and the question was referred to the vote of the people, they worked aggressively for the defeat of the issue. When the bonds were voted, they again showed their attitude, and in the Superior and Supreme Courts of the state, they contested the validation of the bonds. They opposed the district's application to the State Division of Water Rights for a permit to take water from the Mokelumne River, and they opposed the granting of a permit from the Federal Power Commission for a dam to be built at the Lancha Plana site. In all of these measures, the opponents of the project have failed, and at the present time, work is progressing according to schedule.

The laws under which the district was formed, and under which the bonds were sold, compel the payment of bond interest out of taxes, until an income is obtained from some other source. The only other source available is the distribution and sale of water, but in order to perform this function there must be built an adequate distribution system.

Plans for the distribution of the water are now under way, but it has not been definitely decided whether an entirely new system shall be built, or if the district shall entertain the proposition of the purchase of the existing water company, which already have a distribution system in operation.

The magnitude of the Mokelumne River Water Supply Project may be visualized to some extent by analyzing the figures given below, which cover the principal construction features of the project.

PARDEE DAM:

Location—Mokelumne River, 5 miles north of Valley Springs, Calaveras County, California.
Type of Structure—Variable radius arch dam.
Crest of Dam—Elevation 575′, U. S. G. S. datum.
Height of Dam—345′ above river bed.
Concrete—462,000 cubic yards.
Cement—600,000 barrels.
Transportation of Materials—Five miles of standard gauge railroad, to be built.

PARDEE POWER HOUSE:

Location—At downstream toe of Pardee Dam.
Equipment—Two 7500 K. W. Generators.
Capacity—15,000 K. W.

PARDEE RESERVOIR:

This reservoir will be formed by the building of Pardee Dam, and will be the primary storage reservoir for this project.
Maximum Storage Surface—Elevation 567.5′, U. S. G. S. datum.
Outlet Tunnel—Elevation 392′, U. S. G. S. datum.
Total Storage—72,344,000,000 gallons, or 222,000 acre-feet.
Total Available Storage Above Elevation 392′—66,473,000,000 gallons, or 204,000 acre-feet.
Area of Watershed—368,000 acres, or 575 square miles.
Area Flooded—2134 acres.

JACKSON CREEK SPILLWAY:

Location—On divide between Mokelumne River and Dry Creek, at end of north arm of Pardee Reservoir.
Purpose—To allow diversion, as required by the State Division of Water Rights, of excess flood waters of the Mokelumne River to Dry Creek, where the water may be stored by other parties for irrigation uses in the Lower Mokelumne River area.
Type of Structure—Siphon spillway.
Maximum Height—33 feet.
Spillway Capacity—16,000 second-feet.

SOUTH SPILLWAY:

Purpose—This structure permits the storage of water in Pardee Reservoir to elevation 567.5′. The structure dams a low saddle directly south of Pardee Dam and will release excess flood waters of the Mokelumne River from Pardee Reservoir.
Type of Structure—Combination of weir and siphon spillway.
Crest Elevation of Spillway—Varies from elevation 567.5′ to elevation 572.5′.
Spillway Capacity—When the water surface of Lake Pardee is at elevation 575′, the combined capacity of the various units is approximately 50,000 second-feet.

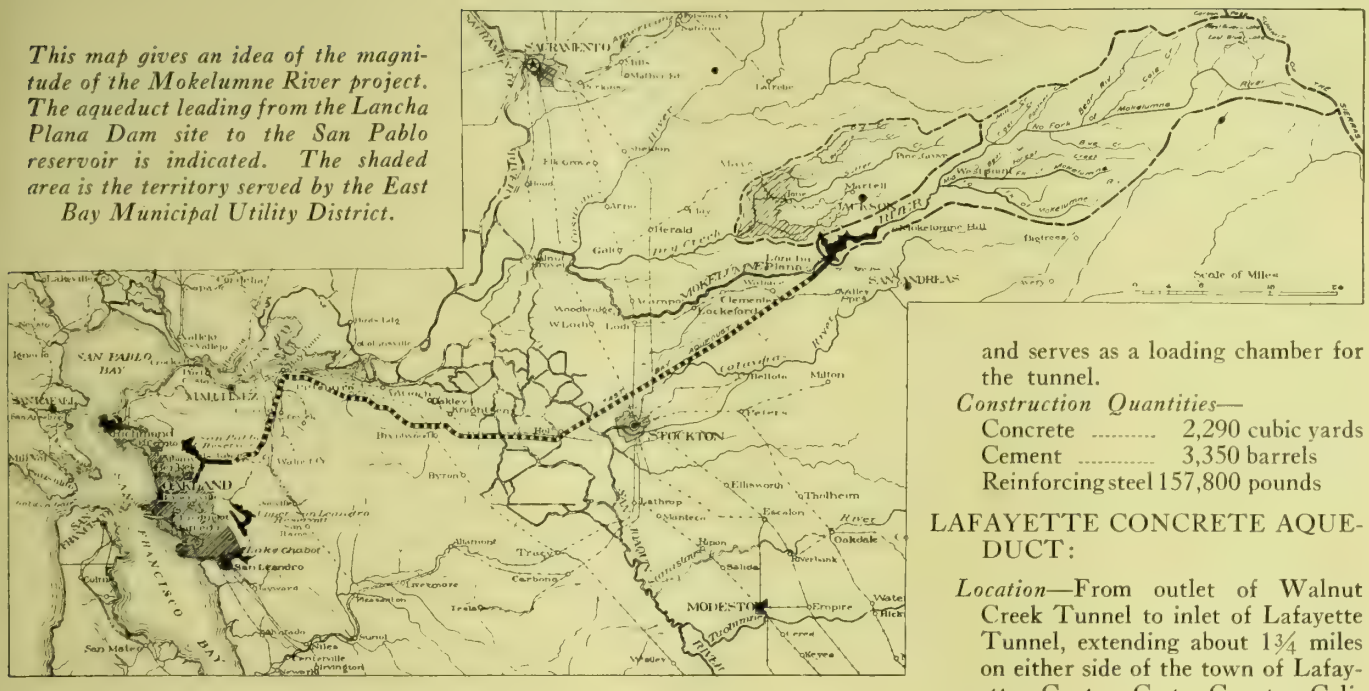
PARDEE TUNNEL:

Length—11,659 feet.
Purpose—Outlet tunnel from Pardee Reservoir.
Size and Shape—8′ horseshoe section.
Details—Concrete-lined pressure tunnel; maximum head on tunnel 167.5 feet.

EAST BAY AQUEDUCT — PIPE LINE No. 1:

Location—From the outlet structure of Pardee Tunnel, which is about 3.5 miles northwest of Valley Springs, Calaveras County, California, the pipe runs in a nearly straight line, 37 miles southwesterly to Holt, San Joaquin County. From Holt, the pipe parallels the right of way of the Santa Fe Railroad 11 miles, westerly, to Bixler, Contra Costa County; and continues in a general northwesterly direction 24 miles to Bay Point, Contra Costa County. The pipe line then goes 10½ miles in a direct southwesterly line from Bay Point to the Walnut Creek Tunnel, about 1¾ miles from Walnut Creek, Contra Costa County.

Extracts from the annual report of the East Bay Municipal Utility District for the year 1926.



This map gives an idea of the magnitude of the Mokelumne River project. The aqueduct leading from the Lancha Plana Dam site to the San Pablo reservoir is indicated. The shaded area is the territory served by the East Bay Municipal Utility District.

Construction Quantities:
Steel—75,000 tons, or 150,000,000 pounds.
Excavation—1,050,000 cubic yards.

Method of Operation and Capacity—The pipe line may be operated either by gravity, or by gravity flow combined with pumping at Walnut Creek pumping plant. When operated by gravity, the pipe line will deliver about 31,000,000 gallons daily at Walnut Creek Tunnel, when the water surface of Pardee Reservoir is at elevation 520′. This amount will increase with the raising of the water surface in Pardee Reservoir, and when it is at elevation 567.5′, the pipe will deliver about 37,000,000 gallons daily. When operating by gravity to Walnut Creek pumping plant, and then pumping the water up to Walnut Creek Tunnel, the pipe will deliver 60,000,000 gallons daily to the pumping plant, when the surface of Pardee Reservoir is at elevation 520′. The steel pipe line is protected from collapse, which might result from a vacuum due to break of the pipe and the consequent rush of water to the break, by the installation of vacuum relief valves at every major break in slope of the pipe. These valves will allow air to enter the pipe line to relieve any vacuum which may exist. As a further protection against damage from breakage of the pipe and the resulting flood of water if the pipe line completely emptied from one place, four 24″ automatic synchronous stop and relief valves have been provided in places where no damage would result from the waste waters. These valves are so adjusted as to open whenever a material increase in velocity of the water occurs. Therefore, if a break occurs, the valves open and allow the water to flow out from four places, thus reducing the quantity at any one place and expediting draining of the line.

WALNUT CREEK PUMPING PLANT:

Location—About 1¾ miles north of Walnut Creek, Contra Costa County, California.

Purpose—To increase the capacity of the pipe lines.

Equipment and Capacity—Two units—24″x24″, 2-stage centrifugal pumps, direct connected to 1600 horse power, 600 R. P. M., 2300 volt, 3-phase, 60-cycle synchronous motors; capacity 60,000,000 gallons daily.

WALNUT CREEK TUNNEL:

Location—About 1¾ miles northwest of Walnut Creek, Contra Costa County, California.

Length—

Tunnel section	2,122.00 feet
Aeration weir	121.75 feet
Outlet section	192.00 feet
	2,435.75 feet

Cost and Date of Completion—$181,250.82—September 10, 1926.

Size and Type of Construction—8′ horseshoe shape, concrete lined, non-pressure tunnel.

Details—The aeration weir at the inlet end of the tunnel is designed to aerate the water, which has been in a closed conduit for 82.5 miles, and serves as a loading chamber for the tunnel.

Construction Quantities—

Concrete	2,290 cubic yards
Cement	3,350 barrels
Reinforcing steel	157,800 pounds

LAFAYETTE CONCRETE AQUEDUCT:

Location—From outlet of Walnut Creek Tunnel to inlet of Lafayette Tunnel, extending about 1¾ miles on either side of the town of Lafayette, Contra Costa County, California.

Length—18,694 feet, including the screening chamber.

Size and Type of Construction—9′ inside diameter, circular aqueduct built of reinforced concrete. The size and spacing of the reinforcing bars is varied, for every 10-foot increase of head, to accommodate a maximum head of 100 feet.

Construction Quantities—Reinforced concrete:

Aqueduct	20,800 cu. yds.
Screening chamber	420 cu. yds.
Miscellaneous structures	140 cu. yds.
	21,360 cu. yds.
Cement	33,600 barrels
Reinforcing steel	4,500,000 pounds
Excavation	140,000 cu. yds.

Details—Incorporated with the aqueduct is the Lafayette screening chamber, where the water will pass through ¼″ mesh screens and any coarse debris will be screened out of the water at this place. The district has purchased approximately 32 acres of land lying to the west of the screening chamber as a site for a filtration plant, if required. The present opinion is that the Mokelumne water will not need filtration.

LAFAYETTE RESERVOIR:

Location—About 1¼ miles southwest of Lafayette, Contra Costa County, California.

Storage Capacity—11,900 acre-feet, or 3,875,000,000 gallons.

Maximum Storage Surface—Elevation 500′, U. S. G. S. datum.

EAST BAY AQUEDUCT—PRESENT CONSTRUCTION PROGRAM

Feature	Capacity	Length Feet	Length Miles	Type of Construction
				8′ horseshoe shaped, concrete
Lancha Plana Tunnel	200 M.G.D.	11,659	2.21	lined.
Pipe Line No. 1	31-60 M.G.D.	118,289	22.40	65″ steel pipe in trench.
		24,039	4.55	63″ steel pipe in trench.
		31,882	6.04	61″ steel pipe in trench.
				Double steel pipe line, 54″ diame-
San Joaquin River				ter, including transfer con-
Submerged Crossing	200 M.G.D.	1,013	0.19	nections.
Pipe Line No. 1	31-60 M.G.D.	19,099	3.62	61″ diameter steel pipe in trench.
Pipe Line No. 1	31-60 M.G.D.	25,028	4.74	63″ diameter steel pipe on piling.
		6,666	1.26	65″ diameter steel pipe on piling.
				Double steel pipe line, 54″ diame-
Middle River				ter, including transfer con-
Submerged Crossing	200 M.G.D.	979	0.18	nections.
Pipe Line No. 1	31-60 M.G.D.	7,411	1.40	65″ steel pipe on piling.
Old River				54″ double steel pipe, including
Submerged Crossing	200 M.G.D.	937	0.18	transfer connections.
Pipe Line No. 1	31-60 M.G.D.	14,924	2.82	Steel pipe on piling, 63″ diameter.
Pipe Line No. 1	31-60 M.G.D.	1,500	0.28	63″ steel pipe in trench.
		171,350	32.45	65″ steel pipe in trench.
Pumping and surge lines	31-100 M.G.D.	(5,340)	1.04	65″ surge line steel pipe.
		(5,485)		63″ pumping line steel pipe.
				8′ horseshoe shaped, concrete
Walnut Creek Tunnel	200 M.G.D.	2,436	0.46	lined.
Lafayette Concrete Aqdt.	200 M.G.D.	18,694	3.54	9′ circular, reinforced concrete.
Lafayette Tunnel	200 M.G.D.	16,136	3.06	8′ horseshoe, concrete lined.
Claremont Tunnel	200 M.G.D.	18,060	3.42	9′ horseshoe, concrete lined.
Total Length			93.84	

Outlet Pipe—Capacity, 25,000,000 gallons daily; lower opening, elevation 380′.

Area of Watershed—914.7 acres, owned in fee by the district.

Construction Quantities — Lafayette Dam:

Hydraulic earth fill	1,950,000 cu. yds.
Riprap and gravel facings	50,000 cu. yds.
Concrete	5,600 cu. yds.
Reinforcing steel	193,000 pounds
Excavation for cut-off, etc.	120,000 cu. yds.

Purpose—The Lafayette Reservoir will be used for three purposes, namely—

1. Equalizing reservoir.
2. Emergency storage.
3. By-pass for water into Upper San Leandro Reservoir. The storage in Lafayette Reservoir would supply 25,000,000 gallons daily for 144 days, if the necessity arose.

LAFAYETTE TUNNEL:

Location—The inlet is about 1¾ miles east of Lafayette, while the outlet is about ½ mile north from Orinda, on San Pablo Creek, in Contra Costa County, and is about 5 miles south of San Pablo Dam.

Length—

Tunnel section	15,169 feet
Approach section	920 feet
Wasteway and screening chamber	47 feet
	16,136 feet

Size and Description—8′ horseshoe shape, concrete lined, non-pressure tunnel.

Construction Quantities—

Concrete	13,000 cu. yds.
Cement	20,500 barrels
Reinforcing steel	355,000 pounds

Construction Features—The screening chamber and wasteway at San Pablo Creek is the outlet from Lafayette Tunnel; the inlet to Claremont Tunnel; and also acts as an outlet for excess water being conveyed from the Mokelumne River. The last feature is unique, in that as the use of water in the district fluctuates, any excess over that being used will find an automatic outlet from the aqueduct through flap gates into San Pablo Creek. It will then flow down San Pablo Creek to San Pablo Reservoir. From San Pablo Reservoir, the water may be conveyed to the district as needed, through the present outlet tunnel, to the Albany filtration plant.

CLAREMONT TUNNEL:

Location—The inlet is approximately ½ mile north of Orinda, Contra Costa County, and the outlet is north of Chabot Road, near the intersection of Broadway and Chabot Road, Oakland, California.

Length—18,060 feet.

Size and Description—9′ horseshoe shape, concrete lined, non-pressure tunnel.

Construction Quantities—

Concrete	20,200 cu. yds.
Cement	31,200 barrels
Reinforcing steel	460,000 pounds

Construction Features — The Claremont cistern will be located at the outlet of the Claremont Tunnel. Included with this cistern are the control valves for the Rockridge Siphon, the Sequoia Aqueduct and the Wildcat Aqueduct. The cistern will provide a complete control of the flow in the distribution mains and closing of the valves will back the water up so that it will flow out through San Pablo wasteway into San Pablo Reservoir. During the early years of operation of the aqueduct, when Claremont Tunnel is not running full, the tunnel will provide storage for about 9,000,000 gallons, or about six hours' use, at the present demand.

CONNECTING SYSTEM

CLAREMONT LABORATORY:

Location—Near outlet of Claremont Tunnel.

Purpose—To house pumping, measuring and chlorinating equipment for the district water supply.

Equipment—Three Venturi meters—necessary chlorinators.

Details—From the Claremont Tunnel gates, water will flow through three parallel 54″ pipe lines, each with a Venturi meter located beneath the laboratory building. After passing through the laboratory, one line turns to the north and becomes the Wildcat Aqueduct. The remaining pipes continue across Temescal Creek, and form the Rockridge Siphon, discharging into Rockridge Reservoir.

ROCKRIDGE SIPHON:

Length and Size—A double line of 54″x7/16″ pipe, 1215 feet long, or a total pipe length of 2430 feet.

Construction Quantities—

Excavation	12,000 cu. yds.
Reinforced concrete	1,050 cu. yds.
Plain concrete	110 cu. yds.
Reinforcing steel	68,000 pounds
Steel plate in pipe	330 tons

Purpose—To connect Claremont Tunnel with Rockridge Reservoir.

Details—Incorporated with the construction work on the Rockridge Siphon is a reinforced concrete underpass to be built beneath the tracks of the San Francisco-Sacramento Railroad. The Rockridge Siphon passes through this structure, which also affords access to all of the works at the west end of the Claremont Tunnel.

ROCKRIDGE RESERVOIR:

Location—In the block bounded by Brookside Avenue, Hays Avenue and Valley Road in Oakland, California.

Purpose—To serve as an equalizing and balancing reservoir for the distribution system in the central and

southern parts of the district.

Details of Structure—The topography of the site allows water to be stored at two levels—elevation 330 and elevation 305, by the construction of two reinforced concrete Ambursen type dams, the heights being 40 feet and 45 feet, respectively. The reservoir will be lined with concrete and will be completely enclosed with a reinforced concrete wall, and covered with an asbestos shingle roof, supported on columns of reinforced concrete.

Storage Capacity—
Upper Reservoir, 5,083,400 gals., or 15.6 A. F.
Lower Reservoir, 18,741,700 gals., or 57.5 A. F.

Construction Quantities—

Reinforced concrete	5,600 cu. yds.
Reinforcing steel	215,000 pounds
Cement	7,000 barrels
Excavation	22,000 cu. yds.

SEQUOIA AQUEDUCT:

Inlet Elevation—When the water surface of Rockridge Reservoir is at elevation 330, the inlet elevation of the Sequoia Aqueduct is 330 feet, U. S. G. S. datum.

Purpose—To connect the various distribution mains and storage reservoirs with the main pipe line, by means of a high line aqueduct.

SEQUOIA RESERVOIR:

Location — Southeast Oakland, near intersection of Golf Links and Stanley Roads.

Maximum Storage Surface—Elevation 300 feet, U. S. G. S. datum.

Total Storage—73,000,000 gallons.

Type of Dam—Due to the topography of the site and the elevation at which it is desired to store water, two dams are necessary. That at the upstream end of the reservoir will be a reinforced concrete multiple arch dam, 70 feet high, while that at the downstream end will be a rolled earth fill dam, 75 feet high, with a puddled earth core.

Construction Quantities—

Reinforced concrete	4,300 cu. yds.
Cement	5,400 barrels
Reinforcing steel	113,000 pounds
Structural steel	30,000 pounds
Excavation	7,000 cu. yds.
Rolled earth fill	131,000 cu. yds.

This description has been made to gather, in convenient form, the pertinent facts of each part of the Mokelumne River Supply Project of the East Bay Municipal Utility District, and as accurately as it can be done at the present time.

WILDCAT AQUEDUCT:

Inlet Elevation—When the Claremont Tunnel is carrying 200 M.G.D. the inlet elevation to the Wildcat Aqueduct is 337.12 feet, U. S. G. S. datum.

Purpose—To provide a high line aqueduct for water distribution in the territory in the north end of the district.

WILDCAT RESERVOIR:

There has not yet been sufficient investigation made to give an accurate description of this feature.

Purpose—To provide an equalizing storage reservoir for the distribution system in the northern territory of the district.

SEQUOIA AQUEDUCT
PIPE SIZES, LENGTHS AND POINTS OF DIVERSION

Type of Construction	Size and Capacity	Length Feet	Terminus	Zone Supplied by Diversion
Pipe	56" 44 M.G.D.	22,000	Rockridge Reservoir Central Reservoir	Diversion of 10 M.G.D. to supply Alameda and 39th Avenue Reservoir Zone.
Pipe	51" 36 M.G.D.	30,000	Jones Avenue and Golf Links Road	Diversion of 4.5 M.G.D. to zone extending from Indian Gulch to south line of District between elevation 50 and 150.
Pipe	40" 19 M.G.D.	2,700	Sequoia Reservoir	Branch line connecting Sequoia Reservoir for storage or draft, as required.

WILDCAT AQUEDUCT
PIPE SIZES, LENGTHS AND POINTS OF DIVERSION

Type of Construction	Size and Capacity	Length Feet	Terminus	Zone Supplied by Diversion
Plaza Tunnel		900	Claremont Lab.	
Pipe	51" 32 M.G.D.	28,330	Clear Water Basin San Pablo Filters	Diversion of 7.3 M.G.D. to be used in Richmond District below elevation 50.
Pipe	46" 23 M.G.D.	19,340		Diversion of 5 M.G.D. to be used in Richmond District, elevation 50 to 150, and 18 M.G.D. available for territory to north of District.
Wildcat Tunnel		1,100	Wildcat Reservoir	Connection to Wildcat Reservoir for storage or draft as required.
Pipe	36"	2,930		
			Total length	52,600

Glendale Buys Water System

Glendale, California, has purchased the Sparr Heights water system from William S. Sparr for $46,000. The transfer includes a pumping plant, three wells, two reservoirs and pipe lines in the Sparr Heights section as well as all water rights of W. S. Sparr. This system will become a part of the Glendale city system under the control of the public service department.

Lindsay Adds to Water System

The pumphouse for the well and equipment at the city park, Lindsay, Tulare County, California, has been completed and work has begun on the concrete foundation for the 200,000-gallon storage tank adjoining. A main line will connect the tank with the present water system and pressure pumps will be installed to maintain high pressure in emergencies.

Water Works Men to Meet at San Jose in October

The annual meeting of the California section of the American Water Works Association will be held in San Jose, California, October 5th, 6th, 7th and 8th, 1927.

The following committee has been appointed by the California section of the American Water Works Association to arrange for manufacturers' exhibits:

Alexander Bell, Pacific Coast manager Wallace & Tiernan Co., San Francisco, Calif.; H. M. Dudley, western sales manager, McWane Cast Iron Pipe Co., Los Angeles, Calif.; Fred D. Webster, National Meter Company, San Francisco, Calif.; W. W. Conners, James Jones Brass Co., Los Angeles, Calif.; J. R. Barker, Pacific Coast manager Neptune Meter Co., San Francisco, Calif., chairman.

It is the intention of the committee to carry on the good work of previous committees at the yearly conventions and stage an exhibit that will be of interest to all visitors. There will be ample space for all who have exhibited before and additional exhibitors are cordially invited. Manufacturers desiring space are requested to get in touch with the committee as quickly as possible.

Land Exchange Granted

Spring Valley Water Company has been authorized by the California Railroad Commission to exchange parcels of real estate with Panama Realty Company in San Mateo County, for the purpose of granting a right of way for a pipe line to the realty company, in exchange for a pump site to be acquired by the water company.

METERS & METERING

Water Wastage Greatly Reduced When Metered Services Are Installed

Diminishing Water Resources of Small Towns Create Necessity of Preserving the Supply

By CHARLES ADE*

IT will be my purpose to cover towns ranging from those having a consuming patronage of 100 up to 3,000 water connections, due to the fact that this range will cover and include the greatest number of places that today offer as yet a fertile field of water waste, and one which holds more or less the attention as virgin localities to plow, cultivate, sow and reap, on the part of meter manufacturers of America, and one in which the many respective waterworks superintendents and waterworks engineers are endeavoring to cope with their diminishing water supplies, and the mounting cost of operation which are so seriously eating into the water department revenues and net annual earnings.

These conditions becoming with each advancing year, more apparent, due to increased overhead, increasing demands for increased wages and salaries of officials and operatives, increasing cost of waterworks materials, machinery, supplies and repair costs. Particularly does this increase refer to the new extensions and all that implies, covering cast iron water pipe, trenching, laying, lead, yarn and labor attendant upon same, plus the service pipes, connections and every known cost.

To all of this must be added the increase in the cost of fuel, be it coal or fuel oil, or electric power if bought from some electric power company. Even lubricants, packing, waste and every known commodity used in a waterworks pumping plant has double or tripled in cost since the plant was originally built and put into commission. Added to all this, possibly, is the waste of improper and improvident mismanagement and inefficiency of employes and officials, all of which is a contingency to be encountered and frequently found, more especially in the small town plant wherein it is next to impossible to pay the proper and adequate salary due a first class, painstaking superintendent or general manager.

The Small Town Problem

Unquestionably, it would seem to be a problem to cope with, namely: the profitable and successful management of a waterworks system in a very small town. I often wonder how superintendents really make both ends meet, and keep up their operating and operative expenses, also pay their current bills of maintenance cost. It certainly must be a problem; they must sit up and burn the midnight oil trying to figure it in and figure it out. I should think it must be mostly "out." It must take extreme caution and care and lots of personal hard work to keep these plants from being in the "red" every month or every quarter.

It is quite apparent that a superintendent who can operate plants of the size from 100 up to 250 consumers successfully, and show even a very small net profit at the end of the year, is deserving of considerable praise at the hands of the mayor and city council, or the owners of a plant if it happens to be privately owned. He is deserving of the plaudits of the entire citizenship of his respective town for being able to hold the whole structure together and not have it fall into the hands of a receiver.

Controlling Factors of Water Costs

The operative costs of water, of course, largely depend upon the source from which it is secured. Fortunate is the town that has a fine open water supply of large capacity, located near a suction lift, so it can be delivered by one pumping process to hill elevation, tank or tower; however, there are very few such ideal conditions, but woe betide the small town, or any town, whose water supply is only to be obtained from very deep wells by deep well pumps or air lifts, in which this supply is compelled to be deposited into ground reservoirs, perchance to be cooled, or for sand settlement, or has to be aerated to get rid of sulphur content, or if it has to be taken from a supply of impounding lake or river so polluted that sedimentation, filtration and chemical purification has to be resorted to, and then a second pumping process has to be used to lift it to elevations; under such adverse conditions, the cost and general expense is so magnified that every drop must, or should be accounted for.

Think of the poor waterworks superintendent held accountable for the profitable operation of a plant under such conditions especially if the total number of customers, water takers, are small, and his rates very low. I should think he would sweat blood and get nervous prostration in the operation of same.

As we ascend the scale in point of number of water consumers, and the monthly or quarterly revenue increases, naturally the difference between income and operative expense becomes less pronounced and the burden of responsibility is gradually lifted from the operator's shoulders to a greater or lesser degree, but even under this enlarged waterworks operation, there ensues an ever greatly increased condition, namely: Water waste, that the superintendent of the larger plant has to contend with, which is likely to run away with and eat vitally into the revenues of his plant unless it is carefully watched and contended against; thus danger ever lurks in the operation of waterworks plants.

Flat Rate Produces Waste

Water waste is the greatest microbe that ever attacked a waterworks system. It is to be found and located mostly in the "water hog," a species of careless and indifferent water consumer. He is well connected to the small town waterworks, as well as to the larger city plants, also larger towns plants. He is ever present everywhere; he is that individual who, under a flat rate system believes strictly in "getting his money's worth," and he generally does it. Leaks in his plumbing fixtures spell nothing to him; in fact he loves to hear the trickle, trickle of the water drip, and the gurgle of a water toilet is music to his ears, as he thinks he is getting even with the waterworks department. The name of "Tom Fixit," the plumber, is unknown to him when it comes to the repairing of such leaks affecting water waste, when he is getting his water under a flat rate, all of which stands for and spells water waste losses to the waterworks department of any size plant, be it large or small, rendering such a plant absolutely impotent to stop such

*Presented at the 1927 session of the Short Course Water Works School Dallas, Texas.

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Opens

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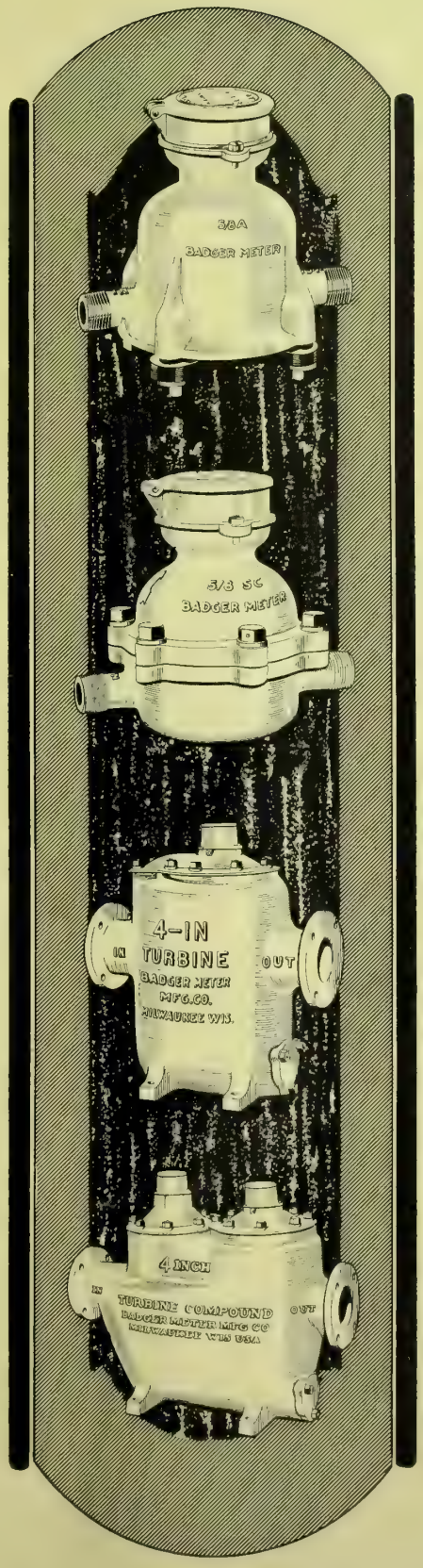
The Meters shown at the right are leaders in the Badger Line. From the small Disc to the large Compound—there is a Badger Meter that will economically and dependably serve you.

Badger Disc Meters are made in sizes ranging from 5/8″ to 4″, inclusive. Turbine and Compound Meters are built from 2″ to 8″, inclusive.

Our Los Angeles office will be glad to give you detailed information of our line of meters.



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Milwaukee, Wisconsin

LOS ANGELES ADDRESS
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BADGER *Water* METERS

For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

losses under such flat rate operation.

The water waste in cities, towns and villages throughout the United States is simply stupendous. If left to go on ad finitum, without eradicating this microbe, this necrosed condition, this waterworks disease, a waterworks plant, no matter how well equipped and operated, never can reach the extreme heights of its profitable operation without calling in Dr. Meters to count its heart throbs and feel the pulse of its commercial cast iron channels and arteries of distribution, which compose the anatomy of this utility. He will prescribe the introduction, and justly so, too, of a universal meter system, injected into or attached to the terminal ends of all water arteries as the only cure-all for this water waste microbe.

The Causes of Water Wastage

The very oldest users of meters are today their strongest adherents.

It is estimated by competent authorities that anywhere from 25 to 60 per cent of all water supplied by an unmetered plant is absolutely wasted. In many cases it runs as high as 100 per cent. In other words, the water wasted is equal to the water used.

Some of the chief causes of water waste are:

1. The flat or scheduled method of selling water.
2. Leaks in pipes or fixtures.
3. Disordered flush tanks in water toilets.
4. Urinals continually running.
5. Opening faucets to prevent freezing.
6. Allowing water to run through hose indefinitely, full stream or partially closed, after using.
7. Wasting water washing vehicles, sidewalks, etc.
8. Continuous flow of water at troughs or fountains.
9. Defective circulation in hot water system.
10. Testing rough plumbing in new buildings.
11. Cooling water circulating through gas engines.
12. Leaks in split wrought iron pipes underground.

There is a record in hand of a man who had a flat rate of $75.00 per annum. A meter was slipped on his pipe and it was found he used $102.00 worth of water the first quarter, this based upon a fair and equitable rate. This was in a small town. Now, everybody is on a meter in that town and it is only natural that the water department should be protected in his way.

Equity and Justice of Metering

There is another point that ought to be considered in the demand for, or the introduction of, meters on a waterworks system, and that is the point of right, equity and justice.

In this modern day and age, it will take very little urging or placation on the part of a waterworks utility to get their consumers to readily agree to being placed on a meter, if the idea is properly and truthfully presented to them. I have in mind as I write a certain town in Texas whose citizens heretofore always absolutely were immune on the subject of meter installation, which they have fought persistently. However, upon recent proper presentation of this subject by the mayor and superintendent, all has now been changed; they have been absolutely won over to the meter idea and are actually asking for meters to be placed on their services.

The writer hopes to arrest the attention of the great body of civil, consulting and waterworks engineers in general to the existing condition of water losses and possibilities of same in plants already in operation, which are unmetered, to the end that they will the more readily recommend the installation of meters when called into consultation regarding the cure for diminishing water supply, and thus save, for the time being at least, the necessity of increasing the pumping plants of their respective plants, thereby cutting down the water consumption and thus, forevermore, curing the water waste evil, at the same time saving the seemingly necessary large expenditure for new increased water supply and, possibly, additional pumps, boilers and enlarged buildings, foundations, etc.

Meters Absolute Necessity

In the lesson presented, which is always inevitable, does it not seem a plausible necessity that in the building of a complete new waterworks system one of the first things to be considered by all engineers selected to make plans and specifications, that meters should be considered as absolutely necessary to the successful and profitable operation of same when the plant is built?

Therefore, their cost and setting should be among the first items considered instead of the last in making up the budget cost of a complete waterworks system. As it stands today, meters are seldom ever considered or provided for in the bond money to be voted upon. If they are, it is a very unusual case. They are rarely ever given any consideration whatsoever in the original estimates.

If they are at first considered, their purchase is generally left until the last and, most generally, finally and completely eliminated because of a shortage of funds with which to purchase same.

It seems really too bad that such is generally the case and meters are left to be purchased at some time in the future, which purchase and installation many times are delayed for years; in the meantime, flat rates have been introduced, with the possibility of water wastes and losses as heretofore set forth. Another point is that having originally established flat rates, it makes it very difficult finally to induce the consumers to accept meters after they have, for years, enjoyed the privilege of a flat rate, hence much opposition and contention on the part of the consumers has to be overcome.

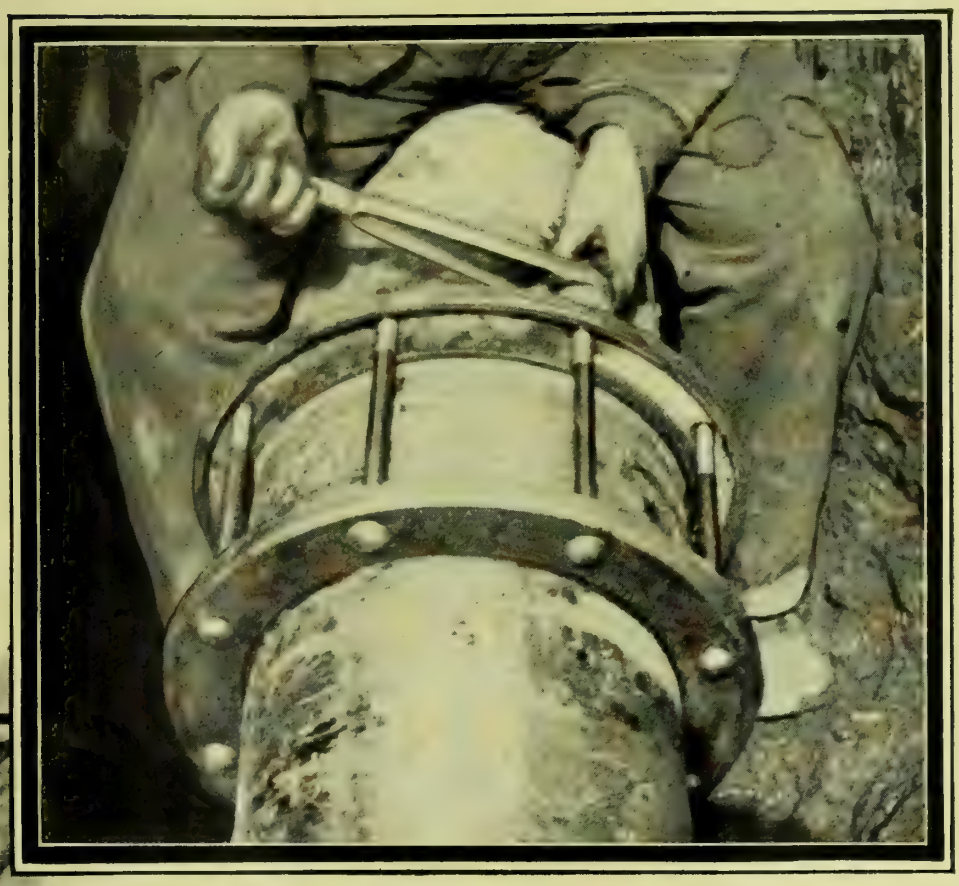
Lowers Insurance Rate

A complete 100 per cent metering is granted a reduced key rate by the insurance companies of this country with reference to the property that they insure in a town that is thus completely metered. It seems to me that some way should be worked out by the waterworks fraternity that the insurance money saved and represented by this saving in the key rate, covering the property insured and the total insurance, thereof in this particular town that is 100 per cent metered, or is going to be, could be collected by the city, or by somebody with authority so to do, into a fund with which to pay for meters and installation of same, covering the accumulation of this fund over a period of a number of months, or possibly, several years, so that meters could be bought and set at the time the new plant is being built. In this case, the insurance companies would really pay for the meters through the saving of an accumulated fund set aside for the purpose produced or secured in key rate reduction.

A Possible Solution

I offer this as a suggestion to be worked out by investigation, providing there seems to be no other way to provide money with which to pay for these meters. This really forms a new angle from which to secure funds for this purpose, inasmuch as the insurance companies are, after all, the real beneficiaries from the installation of these meters; their service particularly benefits them by producing increased fire pressure and water volume, which renders the waterworks system in better shape and condition to protect the insurance companies from fire losses.

As a final culmination of such a process as this, the key rate would be established at once upon completion of the plant, the meters would finally be paid for out of the accumulated fund, and their service to the insurance companies would go on forever.



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Buffalo: 957 East Ferry Street
Cleveland: 1150 East 26th Street
Minneapolis: 6th St. & Hennepin Ave.
New York: 71 Broadway
San Francisco: 3rd & Market Sts.
Pittsburgh: 6th & Smithfield Sts.
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Possibilities of Water Storage Bear Valley, Idaho

Investigation by Engineers of the Geological Survey Reveals Capacity of 900,000 Acre Feet

The people of southern Idaho, in common with the inhabitants of other Western States whose welfare and prosperity are, to a very large extent, dependent upon the availability of water with which to irrigate their lands, have continually before them the problems involved in making the highest economic use of the available water supply in order to further their agricultural activities.

Climatic and topographic conditions serve to confine these problems for the most part to the plains area of southern Idaho adjacent to Snake River, where more than 2,000,000 acres is now being irrigated. Here it will eventually be possible to utilize for irrigation practically the entire run-off of the upper Snake River basin by means of large storage reservoirs that have been or are being constructed and are contemplated. When this condition has been reached, however, there will still remain large areas of land for which no water supply has been provided.

Eventually, therefore, if the greater portion of the plains is to be reclaimed, a source of water supply outside of the immediate Snake River basin must be found. The most promising source for an additional supply seems to be the Salmon River basin, north of the plains.

Two Surveys Made

Engineers of the Geological Survey, Interior Department, during 1925 made two dam-site surveys and special hydraulic investigations in Bear Valley and Stanley basins, lying 6,200 feet above sea level in the headwater region of Salmon River. It was found that 900,000 acre-feet could be stored in Bear Valley and diverted onto the Snake River Plains, but that such storage and diversion would require two large concrete dams, one 340 feet and one 414 feet high; two earthen dikes, one 140 feet and one 50 feet high; and two tunnels, one 8 miles and one 24 miles in length. The reservoirs created would flood 36,000 acres of land that is now in large part valuable only for grazing. If these sites were used for increasing the flow of Salmon River for developing power the potential power of the Salmon River basin would be increased by 126,000 horsepower for 90 per cent of the time and 254,000 horsepower for 50 per cent of the time.

The results of these surveys and investigations are contained in a report recently prepared by W. G. Hoyt, hydraulic engineer, entitled "Storage possibilities in Bear Valley and Stanley basin, Idaho." This report is in manuscript form and may be examined at the office of the Geological Survey in Washington, D. C., or a copy may be seen at the district office of the Geological Survey in the Federal Building, Boise, Idaho.

Silicate as Water Softener

The only satisfactory way of softening water for domestic use is by an exchange silicate softener, the director of the Geological Survey, Department of the Interior, Dr. George Otis Smith, stated orally on June 25.

This type of softener requires only a small amount of attention about once a week when a few pounds of salt must be used for regeneration, according to Dr. Smith. The cost of the salt is the only operating expense. The water is delivered completely softened.

"The hardness of water can be decreased somewhat by the use of chemicals such as lime, sodium carbonate, or sodium phosphate," Dr. Smith explained. "Tri-sodium phosphate is probably the most satisfactory chemical to add. It is desirable to add the chemicals in definite quantities proportional to the hardness of the water and the amount of water treated. The exchange silicate softener automatically removes all the hardness from any amount of water flowing through it up to the time its exchange capacity falls off so that regeneration is necessary."

Yreka Builds New Septic Tank

The new septic tank for Yreka, California, is now complete, having been built in two months time at a cost of $15,000. The tank is of the latest approved design, of a capacity to serve a population of 2000. As the city grows other units will be added. With the payment for the tank, Yreka's bond issue of $56,000, voted two years ago, is exhausted. The bond issue was to cover $33,500 for additional water supply, pipe lines, and the securing of the lands needed for the supply; $7,500 to re-cement the broken floor of the city reservoir and to put a cover over the reservoir; and the $15,000 for the septic tank.

Wallace & Tiernan Move

Wallace & Tiernan Co., Inc., manufacturers of filter and chlorination plants, have moved their Los Angeles offices from the I. W. Hellman Building, 124 West Fourth Street, to 304 Hohm Building, 3923 West Sixth Street. Their new telephone number is DRexel 2910.

Inspect Mexican Dam Site

Another inspection of the Garcia dam site was recently made by J. W. Williams, engineer for the San Diego water department, and Councilman Virgilio Bruschi, in company with Jose L. Favels, chief engineer of the department of agriculture of the northern district of Lower California.

It is proposed to build a dam on the Garcia site about 160 feet in height, to impound 34,000,000,000 gallons of water, according to a recent report, from the Tijuana river and its branches. Mexican engineers are now surveying the watershed, which covers 1420 square miles, and the work of drilling to find the depth of bedrock for the foundations is progressing so that an estimate of the cost may soon be obtained.

Whether the financing of the project will be carried entirely by the Mexican government, or a share of it be shouldered by San Diego has not yet been definitely decided. Relations with Mexico are highly friendly regarding the project, it is declared, and it is believed that a just determination will be reached as soon as the plans are perfected.

Santa Ana Gets More Water

With the city's new well and pumping plant forcing 2250 gallons of water perminute into the mains, Santa Ana, California, has no fear of any water shortage this summer, according to Walter Wray, city water superintendent. The pumps at the plant are working 16 hours a day, giving the city an additional 2,000,000 gallons daily and removing the necessity of taking water from the reservoir which has until now been used as an emergency source of supply. Running at full capacity, the new plant is capable of meeting almost any necessity that might arise. Only in the case of a large fire, according to Mr. Wray, would it become necessary to fall back on the emergency reservoir.

Paradon Appoints Coast Agent

The Paradon Manufacturing Company, of Arlington, New Jersey, have recently appointed the Chemical Equipment Corporation, 215 West Seventh Street, Los Angeles, as their representatives in California for the sale and service of Paradon chlorinators.

EL CENTRO, CAL.—The Imperial Valley Irrigation District is contemplating the generation of electricity along the many canals of their properties. This matter is now being given serious consideration by the officials of the district, and will be decided in the very near future.

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PRECAULKED JOINT OR OPEN BELL PIPE

4 Men Laid 3000 Feet In One Day

IF YOU want concrete evidence of the speed and economy possible in laying this cast iron pipe with the factory-made joint, here it is. On a certain job four men laid 3000 ft. in the trench, shoved together and ready for the calkers, in one day . . . at a cost of one cent a foot. Then, the 3000 ft. of pipe was calked in 2½ days at a cost of 2½ cents a foot. The testing developed NO LEAKS.

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WATER PURIFICATION

Elimination of Chloro-Tastes Produced by Organic Decomposition in Water

Super-Chlorination and Double-Chlorination of Raw Water Supplies Introduced to Destroy Chloro Products

By L. H. ENSLOW*

Sanitary Engineer, the Chlorine Institute, Inc., New York

AT THE White Rock filtration plant at Dallas, Texas, Bakke has for the past three seasons successfully carried out super-chlorination of the raw water and subsequent chlorination of the filter effluent. Such practice was introduced for the purpose of destroying chloro products formed between the decomposition products from vegetable matter and algae in the raw lake water and the coagulation basins ahead of the filters. To the filtered water a rather high dosage of chlorine is applied which at all times results in a residual chlorine content of 0.3 p.p.m. or more in the water entering the clear well of large capacity. No complaints for excess chlorine or by-products tastes are heard from consumers during such operating conditions, whereas prior to such drastic chlorination, complaints were many and continuous.

At the Turtle Creek plant at Dallas, Texas, where iron sulphate and lime are employed to coagulate and soften the supply ahead of the filters, Bakke employes double chlorination. The filtered water is chlorinated as it enters a large open clear-water storage basin and again as it leaves the plant for delivery directly into the distribution system. Investigation disclosed that such tastes were being formed within the mains and never in the clear-water storage basin at the plant. The solution of the difficulty was found in the adjustment of the chemicals applied to the raw water. Lowering of the pH value of the filtered water prior to chlorination resulted in the elimination of stabilized available chlorine compounds produced when chlorine was added to the water possessing a higher pH value. The end result was an increased dissipation of the available chlorine which in turn meant that residual chlorine in the water reaching the offending sections of the distribution system and dead ends was absent or else insufficient to produce the foul tasting by-products within the mains. As will later be shown in recounting the experiences of McAmis at Greenville, Tennessee, it is probable that an application of ammonia to the water ahead of chlorination would have solved the difficulties equally as well as regulation of the chemical dosage causing more rapid dissipation of the chlorine. The latter effect is probably a result of eliminating either the formation of or the stabilization of hypochlorites in the water.

Bakke points out that had re-carbonation of the settled water been possible, this process would have been employed rather than the reducing of the lime and increasing of sulphate of iron. Prior to adjustment of pH value of the water ahead of chlorination, super-chlorination without dechlorination has been tried without success.

Super Chlorination Experiments

For the past several years Norman J. Howard, at the Toronto, Ontario, filter plants has been conducting laboratory scale experiments in connection with the chlorination of waters containing phenols, cresols or their derivatives. Such work has been conducted simultaneously with that of Sir Alexander Houston in England and as a result of the favorable outcome of the work of Houston which agreed with the observations made by Howard, he and Thompson in 1926 carried out a very thorough investigation into the actual quantities of chlorine required and the contact period necessary to destroy the various phenols or cresols. Complete data as to the quantity of chlorine required for phenol destruction by superchlorination followed by the contact period available at the Toronto plant and the quantity of sulphur dioxide later required to reduce the excess chlorine to that desirable before discharging the water to the mains were presented to the city authorities. Adoption of the process was authorized in the late summer of 1926. It proved to be immediately effective.

In the application the entire plant output delivered to the city (70 M.G. D.) was from the first super-chlorinated. The dosage of chlorine applied to the effluent of the filters was between 0.75 and 1.25 p.p.m. followed by an average period of contact of 1¼ hours. Sulphur dioxide (0.28 to 0.62 p.p.m.) was next applied to the super-chlorinated effluent at the pump station delivering to the mains. The application of the sulphur dioxide gas was made from cylinders of liquid sulphur dioxide connected to Wallace & Tiernan vacuum type chlorinators which were fitted with special orifices, and other parts where necessary. These machines have performed very satisfactorily and are operated by an attendant who adjusts the dosage so as to barely destroy all residual chlorine in the water delivered into the mains.

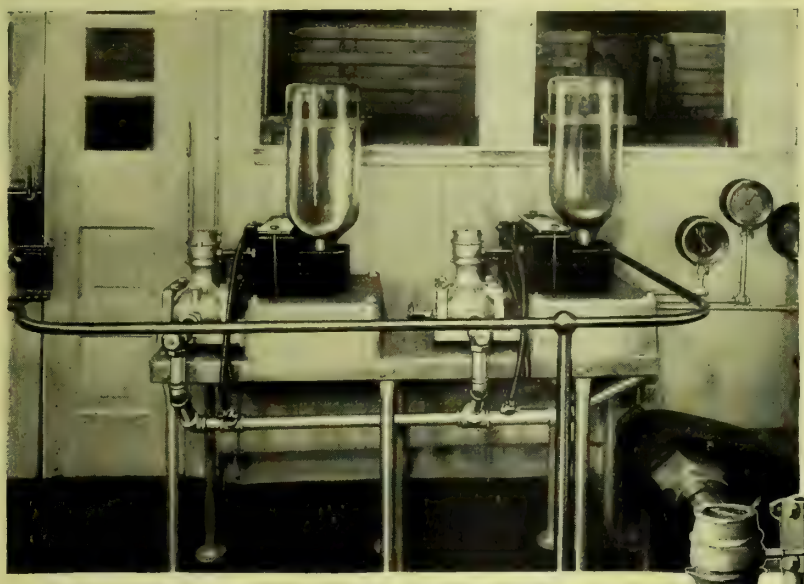
Excess Chlorine Required

Howard reports that whereas the theoretical relationship between the sulphur dioxide necessary to destroy a given excess of chlorine is 0.9 lb. of sulphur dioxide for 1 lb. of chlorine, it appears in actual practice that 1 part of chlorine requires 1.12 parts of sulphur dioxide, i.e., a quantity 25 per cent in excess of the theoretical. Under certain conditions as much as 50 per cent in excess was required. It was also found that during heavy rates of discharge the pressure in the sulphur dioxide cylinders was difficult to maintain unless a temperature above 80° F. was provided, or unless a relatively large number of cylinders were connected to each machine. Recently steam coils have been placed between the cylinders to facilitate rapid delivery of the gas.

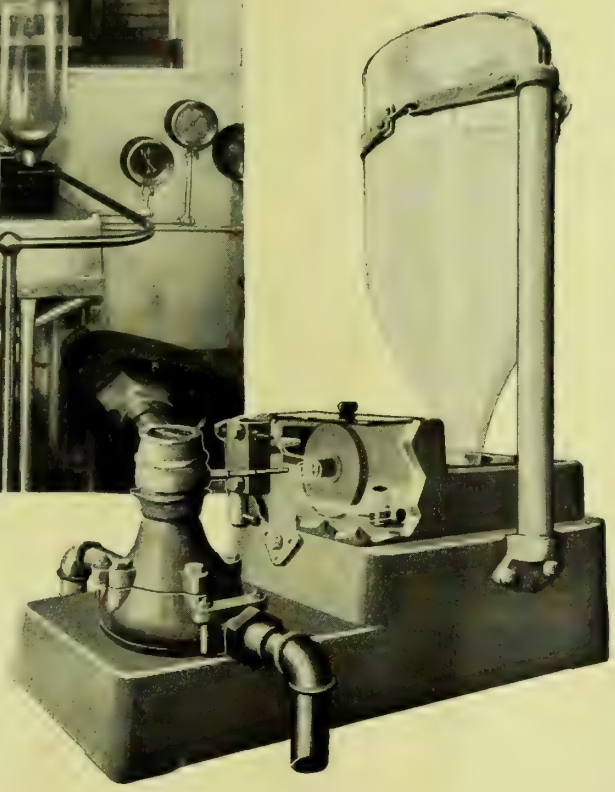
It was interesting to note that a small portion of the Toronto supply could not be super-chlorinated and de-chlorinated and during the first period of super-chlorination the main supply developed no taste, whereas that not super-chlorinated was noticeably foul tasting. During a short period after beginning super-chlorination the sulphur dioxide supply was exhausted and with the discontinuance of super-chlorination the foul taste returned to the main supply.

Super-chlorination and de-chlorination have been applied to 70 M.G.D. flow at Toronto for a total of 84 days—it hav-

*Extracts from a paper presented at the 47th annual convention of the American Water Works Association.



Two W&T Chlorometers installed to sterilize the drinking water supplied to S. S. "Western States" Detroit & Cleveland Navigation Company



Detail W&T Chlorometer showing constant level chamber, feed disc, injector and drive shaft.

Now Even the Smallest Water Supplies May be STERILIZED

THE W&T Chlorometer has been developed for the automatic, proportional application of relatively small quantities of chlorine sterilizing solution.

The water to be sterilized passes through a meter.—The power obtained from the meter drives the Chlorometer.—As the water starts, the Chlorometer starts.—When the water stops, the Chlorometer stops.—The faster the water flows, the faster the solution is fed.—The slower the water flows, the slower the solution is fed.

Intended largely for small water supplies and for indoor swimming pools, the W&T Chlorometer is absolutely automatic in operation, requiring no attention other than replenishing the sterilizing solution.

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ing been discontinued Dec. 8th, 1926, because of lack of the necessary appropriation. Immediately following discontinuance foul tastes developed and persisted for a few days until the wind direction changed and the pollution was driven from the vicinity of the raw water intake. Since then complaints have been intermittent, depending upon the meteorological conditions.

Howard recently reports that a greater chlorine dosage is required at times when the water temperature drops below 42° C. Although 1.25 p.p.m. appeared sufficient under summer and fall conditions, the cold water during winter requires as much as 2.00 p.p.m. to be effective with the contact period available, viz.: 1¼ hours. This situation is believed to be a result of lessened biological activity in the raw water in cold weather and therefore a greater concentration of undestroyed phenols with which super-chlorination must cope.

Super-Chlorination Resumed

The city council has sanctioned the return to super-chlorination and de-chlorination at Toronto and has appropriated the necessary funds for equipment of increased capacity. Within a short time the process of super-chlorination and de-chlorination will be in use again. The estimated cost even with the heavy winter dosages will amount approximately to $32,000 per year with continuous application. The cost of treatment will average something less than 1.75 per million gallons. The use of chlorine in ton containers at the Toronto plant would reduce cost of super-chlorination materially.

Harrison who has conducted laboratory experiments at Bay City, Michigan, has confirmed the results reported by Howard and Thompson in their preliminary work at Toronto. Harrison finds also that it is imperative to insure a sufficiently high residual chlorine (never less than 0.6 p.p.m.) and thereafter a contact period of two hours prior to de-chlorination. Harrison finds, as Howard has, that a gradual increase of chlorine aplied to water containing phenols will produce a foul taste which upon further increase of chlorine will be lessend and finally disappear. Further increases again result in re-appearance of foul tastes and finally super-chlorination effectively and permanently destroys the taste after the necessary contact period has been allowed.

The Use of Ammonia

In Canada, Race successfully employed for sterilization purposes, a mixture of hypochlorite solution and weak ammonia water. Improved taste of the water so treated was secured at the expense of rapid sterilization. Thresh also reports the successful use of this method in England at a water works using river water. Major Harold of the British Army has succeeded in producing chloramines from chlorine water and ammonia water and in obtaining a patent on the process of first producing chloramines from chlorine gas and ammonia solution and thereafter applying such solution to the water, etc.

In England both Sir Alexander Houston. and B. A. Adams reported very effective results obtained in chloro-taste prevention, when applying ammonia in conjunction with liquid chlorine. Houston applies the ammonia to the water prior to the chlorine application. Adams prefers to mix the ammonia solution and chlorine solution just prior to admitting the mixture to the water. Houston refers to the latter method as that of Harold and after comparison of the two methods experimentally, points out the various advantages and economic aspects of each method. On the whole, Houston favors the application of the ammonia to the water at a point ahead of the point of chlorine application. Comparing the use of the permanganate ahead of chlorine aplication with the ammonia-chlorine combination the results are in favor of the latter method. Houston points out that application of approximately 0.25 p.p.m. of ammonia (NH_3) is sufficient in most cases to prevent taste production when the chlorine is later applied. On the other hand, ammonia added after chlorination will not remove the chloro-taste once it has been produced.

Adams claims greater efficiency from the Harold process and prefers gaseous ammonia to ammonium salts in any event.

Pipe Source of Chloro-Taste

At Greeneville, Tennessee, during the past several years complaints of chloro-tastes, "iodoformish," have been frequent during the summer months. The water supply is derived from a limestone spring not subject to pollution by phenol wastes or other industrial wastes. This normally clear but hard spring water is softened and clarified with lime and iron sulphate, and thereafter filtered. To eliminate the intermittent chloro-tastes J. W. McAmis, Supt. of the Water Works, attempted to super-chlorinate without subsequently dechlorinating and later tried double chlorination also, without material success in either case. In double chlorination a primary dosage was applied to the raw water and the secondary dosage applied to the water leaving the clear well to enter the distribution system.

It is interesting to note in the report of McAmis that the chloro-tastes never developed in samples collected at the softening plant and even in the distribution system in which the tastes developed intermittently the water temperature range during taste production always was found to be between 17° and 23° C. He further points out that a possibility exists wherein the pipe coating material of foreign substances within the service tanks or mains might be the source of the state production.

In any event, not being successful in various other attempts at taste eradication, McAmis, being familiar with the ammonia-chlorine combinations used by Houston with success, attempted the use of ammonia water prior to the chlorine aplication. This marks the first attempt on a plant scale with the process in America.

First Application of Ammonia in America

In the first trial ammonia water was applied to the raw water prior to application of softening chemicals. The chlorine was applied—as previously—at a point about half way of the mixing chamber and after the softening chemicals had begun to coagulate in the water. The process was an immediate success and chloro tastes entirely disappeared from the distribution system. Discontinuance of ammonia application resulted in the re-appearance of chloro-tastes.

Having had undeniable success with this scheme, the ammonia application was continued to the raw water but the point of chlorine application was changed to the filter effluent. The tastes were not formed under the latter operating procedure and therefore the chlorine is being applied to the filter effluent to date. McAmis points out, however, that the lagging of efficiency of sterilization was observed when employing the ammonia-chlorine treatment and thus a longer period of contact is required than otherwise. It would appear therefore that with absence of available period of contact elsewhere the chlorine should be applied at the inlet end of the coagulating basin.

McAmis also calls attention to the very slow development of maximum color when ortho-tolidin is added to the ammoniated-chlorinated water, presumably containing chloramines rather than free chlorine or hypochlorites.

Method of Preparing and Feeding Ammonia

The high solubility of ammonia gas in cool water enables one to prepare the ammonia solution quickly with but simple equipment. A mixing device and gas diffusor are not essential in the dissolving tank but may prove advantageous. The ammonia water is fed from an ordinary orifice box.

The method employed by McAmis fol-

Pure Water

YOU do not allow your fire insurance to lapse because you have never had a fire and no one can tell exactly when a water, normally satisfactory, will require extraordinary treatment to combat sudden increases in pollution. A properly designed and operated Water Purification plant will remove over 98% of the bacteria mechanically, and by sterilization the removal may be made practically complete.

Filtration

All water purification plants are identical in the general principle of passing the water through filter beds of graduated sand and gravel. In some cases the water is retained in sedimentation basins for varying periods, and in virtually all cases a small amount of aluminum sulphate is added to the water before it is allowed to flow onto the sand beds. The sulphate forms a jell-like mass which imprisons suspended matter very much in the same way as the "eggs - in - the-coffee," idea. The filters completely remove the accumulation, as the water passes through the sand.

A FEW

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Sterilization

The Michigan State Board of Health Bulletin stated: "City officials are learning that it is much cheaper and safer to chlorinate water supplies than to try to keep the source in a state of natural purity. During 1920 typhoid fever cost citizens of the State more than $1,-500,000.00." Liquid Chlorine water sterilization is a municipal life insurance policy costing a premium of *two* cents per capita per year—an insurance policy every city should purchase where there is any suspicion as to its quality. The premium is small—the benefits immeasurable.

This is one of a series of "advertorials" co-operatively designed to broadcast a more general knowledge of the relation between the public water supply and community health.

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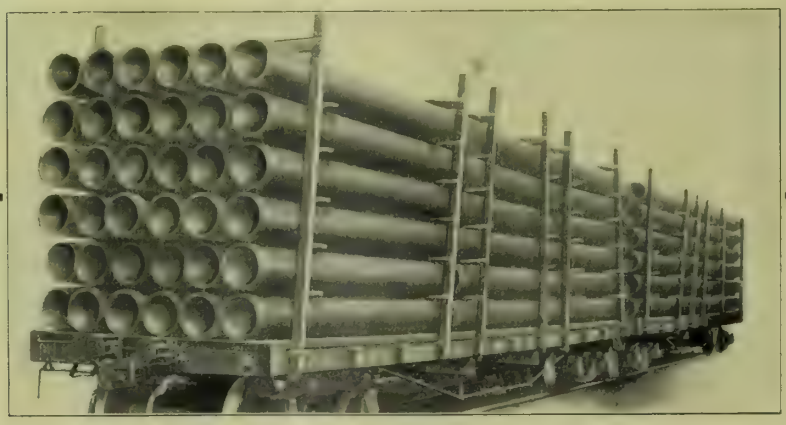

Drainage and Flood Control Engineering

By G. W. PICKELS
Assistant Professor of Drainage Engineering,
University of Illinois

THIS BOOK COVERS ALL PHASES OF THE DRAINAGE ENGINEER'S WORK FROM THE DRAINAGE OF SMALL AREAS OF FARM LAND BY TILE UNDERDRAINS TO THE RECLAMATION OF LARGE AREAS BY FLOOD PROTECTION, BY DRAINAGE THROUGH OPEN DITCHES AND BY PUMPING.

450 pages, 6x9, Illustrated. $4.00 Net

The marked advance in drainage practice in recent years is emphasized throughout. The sciences of hydrology, hydraulics and soil physics—particularly the results of recent researches—are satisfactorily covered from the specialized viewpoint of the drainage and flood-control engineer.

The book gives a comprehensive and well-balanced picture of drainage practice as carried on today. The economic justification of drainage and flood-control projects is set forth clearly. The legal organization of drainage districts, the essentials of drainage law, and the spreading of assessments make up a final valuable chapter.

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lows: The steel cylinder containing liquid ammonia is placed on a platform scale. The cylinder is preferably located at an elevation above the flow line of the steel solution tank. A black iron pipe of ¼ in. diameter conveys the gaseous ammonia to the bottom of the solution tank and the flow of ammonia is regulated with a ⅛ in. needle valve. The valve is opened very gradually until a cracking noise is heard in the tank which indicates the flow of ammonia. The feed is continued until the desired weight of ammonia has been dissolved. A too rapid feed will result in water backing up into the feed line and eventually into the cylinder. The strength of ammonia solution should be determined by the rate of flow of water being treated and the volume of the solution tank, thus preparing a solution which will be delivered during a period of 8 hours or thereabouts. Ordinarily the weaker the solution prepared the less loss will result from ammonia escaping during feeding and upon standing exposed.

Amount of Ammonia Necessary

At Greeneville, Tennessee, 0.25 p.p.m. (2.08 lbs. per m.g.) ammonia (NH_3) apparently gave satisfactory results at all times and at times even lower dosages also proved effective. Increased dosages failed to impart any tastes to the finished water. *NOTE: It would appear therefore that a tank of 100 gal. solution capacity would serve when supplying ammonia at the rate of 0.25 p.p.m. to water passing at the rate of 10 M.G.D. for 7 hours. The strength of solution prepared would be 0.75 per cent of NH_3 by weight, i.e., 0.25 lbs. of ammonia gas (NH_3) in 100 gal. of water. If loss of ammonia is noticeable the solution strength should be reduced and increased tank capacity provided. The ammonia solution should be delivered from the tank into the water with a minimium of free fall or splash.*

Cost of Treatment

Houston reports cost of chemicals in the ammonia-chlorine process to be 41 cents per millions gallons of water treated.

McAmis operating on a much smaller scale and higher cost of chemicals reports the cost to be about 60 cents per million gallons treated.

Will Discontinue Water Service

John Rentz, operating a public utility water system in the vicinity of Capitola, Santa Cruz County, has applied to the California Railroad Commission for authority to discontinue public utility water service, applicant stating that The Capitola Company is now supplying consumers within the territory supplied by him, and that The Capitola Company is much better equipped to provide service.

For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

Hydraulic Society Standards

Standards of The Hydraulic Society has just been issued in a fourth edition, comprising eighty pages, 8½"x11" in size, which compares with a nineteen page booklet, 6"x9", published in 1921 as the first edition.

The new edition is profusely illustrated with charts, tables, drawings and half tones of pumps and pump parts and an effort has been made to produce a publication that will merit the approbation of the engineering profession. It contains sections on definitions and values; extracts from pump test codes; a revised pump classification; description of types, parts and definitions pertaining to the several classes of pumps (reciprocating displacement, rotary displacement, centrifugal and deep well); instructions for installing and operating each type; a recommended contract form for use in the pump industry; data, tables, curves and formula, including pipe friction data for both water and oil and a comprehensive list of materials recommended for pumping different liquids.

Copies may be had at the nominal price of fifty cents each upon application to the secretary, C. H. Rohrbach, 90 West Street, New York.

Measure Flow of Colorado

The Geological Survey of the Department of the Interior has just issued one of its series of annual water supply reports giving the results of the government's stream measurements in the Colorado River basin. In co-operation with various states and other organizations interested in the flow of the Colorado, the Geological Survey maintained during the year ending September 30, 1923, some 80 stream-gaging stations, at most of which were obtained records of daily flow of the river and its tributaries, covering a great drainage basin of some 242,000 square miles.

The first table in the report gives the flow of the Colorado at a point way up in northern Colorado, where the river is a tiny stream with a flow at times of less than 100 cubic feet a second. During the summer flood, which resulted chiefly from melting snow in the high altitudes of the headwater streams, the flow in the Grand Canyon and downward to the mouth was over 100,000 cubic feet a second.

The Colorado River report is largely statistical and covers 175 pages. It may be purchased from the Superintendent of Documents, Washington, D. C., for 25 cents. Ask for Water-Supply Paper 569.

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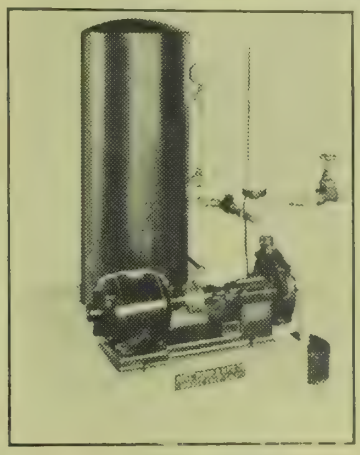

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Waterproof Paint Company
of Lankershim, Calif.

Prosperity of Owens Valley Shown by Recent Statistics

(*Continued from Page 27*)

received during the period immediately following the war.

Bank statements for years from 1922 to 1926 are given. They show that there has been a healthy increase in deposits, an increase in loans and discounts, and a healthy increase in surplus and undivided profits.

Type of Business Has Changed

It would appear that the natives of the Owens Valley are somewhat similar to those of the Tennessee mountains. They have done a certain kind of business for a great many years, and continue to do the same kind of business as was done by their grandfathers. Times and modes of living change, and those who do not keep abreast of the developments of their fellow men, are certain to be sidetracked along the wayside. The type of business for which Owens Valley is now adapted is somewhat different from that of several years ago. Outsiders and business men from other parts

GROSS RECEIPTS OF THE POST OFFICES AT BIG PINE AND BISHOP, CALIFORNIA, BY FISCAL YEARS, FOR THE PERIOD 1921 TO 1926 INCLUSIVE.

Fiscal year ended June 30	Big Pine Calif.	Bishop Calif.	Combined
1921	$3,403	$15,338	$18,741
1922	2,702	15,914	18,616
1923	3,472	16,771	20,243
1924	3,152	16,281	19,433
1925	2,758	14,950	17,708
1926	2,910	14,842	17,752

of the state have seen the advantages that Owens Valley offered the public as a summer playground, and being the type of men that take advantage of such opportunities, they have established many summer hotels and resorts in the valley. As a result the main business of the valley is changing. The period of transition has taken several years, but the older residents have just awakened to the fact that outsiders are taking out the profits.

The people of Inyo County have an asset that ought to be returning them far more than it is now. That asset is their combined climate and scenery. There are few places in the entire world that are comparable with it. There are more than forty peaks, towering above valleys that have never been named, many of these peaks being over 12,000 feet above the sea. There are hundreds of small lakes all within a short distance of Owens Valley towns, and the whole forms a great natural park which, with a small amount of development and cooperation with booster bodies throughout the state, could be made one of the greatest summer playgrounds in California. Should the residents of the valley devote their attentions to the building of roads, to the construction of roads and trails into the higher levels, should they build adequate hotels for the care of tourists, and otherwise do what is possible to supplement the gifts of nature, that country would be enjoying a great measure of popularity.

Pumping Aids Seeped Areas

In the Salt River Valley of Arizona, as well as at a number of other places in the West, excessive irrigation, resulting in deep percolation, together with seepage from canals, has unfitted large areas for cultivation by reason of the raising of the ground-water level. These areas have increased rapidly in extent until corrective measures have become imperative.

Test borings in the Salt River project showed that about half of the project is underlaid by a coarse, water-bearing formation from which water may be pumped; and, as the Salt River Water Users' Association had available a large quantity of cheap electric power generated at its own plant, it was decided to install electric-driven pumps in wells located in the damaged areas to lower the ground-water level. This plan has been successful; water-logged land has been reclaimed; the rise of ground water in sections not yet damaged has been checked, and the pumped water has been used very largely to augment the supply available for irrigation.

New Pump Bulletin

The Worthington Pump and Machinery Corporation, 115 Broadway, New York, N. Y., has issued Bulletin No. W613 on Worthington High-Efficiency Centrifugal Pumps. These pumps have efficiencies of from 8 to 10 points higher than the average centrifugal pump. The bulletin describes the new pumps in detail. It also tells how 10,000 pump inquiries were analyzed to determine the heads and capacities most commonly specified by pump users. With this analysis as a basis Worthington engineers set about designing new lines of high efficiencies especially for those heads and capacities most commonly specified by users.

Concrete Pipe Development Result of Year's Study

(*Continued from Page 22*)

Associated Concrete Pipe Manufacturers to continue the work for another year. We have lost Fred Stanley—killed in action; but the splendid results he accomplished remain, and for these I know that you will revere his memory.

You are all more or less familiar with the results obtained during this preliminary investigation and nothing would be gained by reviewing them. I wish rather to call your attention to the necessity of making similar investigations to insure success in this new field that you are entering. Vigilance alone will not prevent mistakes and failures. You must rely on tests and research. You must put teeth into your by-laws and regulations so as to prevent a small minority of your membership from making and laying poor pipe. When it comes to psychology human beings are very much alike. Our dealer supplies us with dozen after dozen of fresh eggs and we think they are fine. But one fateful morning we get a bad one and later a second and a third. Then we are ready to declare on oath that the whole lot are rotten. Now you may install nineteen good plants but if the twentieth is a failure you will get little credit for any, but be severely criticised for the failure. You should not allow your competitors to pierce your armor without an effort to prevent it. In the past few years, you have learned how to select, mix and make good pipe as well as how to cure and lay it, but there is still much to be learned about expansion and resultant rupture. When dry pipe is buried in dry soil and water is suddenly turned into the line we cannot always predict what will happen. I believe, however, a remedy can be found and I would urge you in conclusion to safeguard an important industry by spending time and money in perfecting your products and preventing failures.

Monte Vista Wants Own System

Plans are under way for the formation of a water district in the Monte Vista section, east of Pomona, California, to provide a more adequate domestic water service with the addition of fire protection. The district proposed includes the property along the east side of the Pomona city limits, as far as the west city limits of Ontario. At the present time only a small part of this territory has domestic water, secured from Pomona, and the other residents are dependent upon cisterns and tanks which are filled from their irrigation supply.

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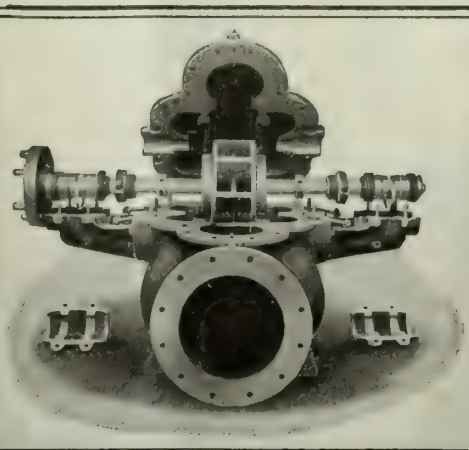

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LEGAL *and* JUDICIAL

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New Theory of Riparian Rights Argued

Defendants declare that the lands of the Sacramento-San Joaquin Delta have no riparian rights.

In a two days' argument before Judge Young of the Superior Court of San Joaquin County, on July 27 and 28, 1927, the defendants presented a new theory of riparian rights in defending their position in the case of Holland Land Company and 142 co-plaintiffs against Williams Irrigation District and some 500 other defendants.

This action was brought by a large number of land owners in the Sacramento-San Joaquin Rivers delta to enjoin all diversions of water from the two rivers, by up-river water users. The plaintiffs' theory rests upon the generally accepted rules of riparian rights.

The situation, however, is unique in that the rivers on which these delta lands front are tidal-navigable waters, and under certain authorities such waters are held not to be subject to the riparian rights of adjoining lands, at least in so far as diversion and use of water is concerned.

The Federal Government also claims a paramount right in the rivers for purposes of navigation, and, in one instance, Congress granted a right to a private corporation to appropriate water from the Sacramento River. This right is now owned by the Glenn-Colusa Irrigation District.

All parties have requested permission to file briefs and the final determination of the law questions by the trial court will be awaited with extreme interest by all water appropriators of the State of California.

Irrigation District Directors Given Additional Authority

Many sections of the California Irrigation District Act interpreted by the Supreme Court.

In the case of Willard, et al., vs. Glenn Colusa Irrigation District, et al., decided Aug. 4, 1927, Vol.—— Cal. Dec.——, the Supreme Court of California passed upon many points of interest to irrigation districts of the State.

In 1922 the district had adopted certain rules and regulations and fixed water tolls and charges on an upward sliding scale, the purpose being to cut down waste and also, by reason of such tolls, require the users of excessive amounts of water to pay additional amounts necessary for drainage purposes. The plaintiffs bring an action to enjoin the collection of the tolls and the adding of the same to the assessment. The trial court granted the injunction which was reversed on appeal. The constitutionality of the entire toll scheme was in question on the hearing.

The Supreme Court in its decision gave its opinion on the points involved, as follows:

(a) The provisions of Sec. 55 of the irrigation district act providing for the levy and collection of tolls for the furnishing of water are not unconstitutional.

(b) The amount of tolls is not limited to the 2 per cent of the assessed value of the lands.

(c) Tolls can be used for "drainage work" which is construed as being a part of the "operation and maintenance" of the district irrigation system.

(d) The directors have the right to provide for an upward sliding scale of toll charges, or use any other reasonable means of preventing waste of water.

(e) Water tolls can be collected in installments, in advance.

(f) The directors can meter certain lands and not others where there is a reasonable basis for such distinction.

(g) The unpaid water tolls can lawfully be added to the annual assessment.

Future Benefits to Be Considered in Fixing Amount of Assessment

The question of benefits to be derived from reclamation is largely within the discretion of the assessors.

In assessing the lands in Reclamation District No. 2047 in Glenn and Colusa Counties, the assessors levied an assessment on certain lands planted to alfalfa and which it was claimed were not in need of drainage or irrigation.

In answer to this contention, the Supreme Court of California in the case of Abel vs. Reclamation District No. 2047, 74 Cal. Dec. page 9, lays down certain rules, as follows:

"Plaintiff's most insistent objection to the improvement is that his lands will not be benefited either by drainage or irrigation works. . . . It is a fact, however, that the lands abutting on three sides of his lands had for several years been annually flooded during the summer seasons by his neighbors who are engaged in rice culture. On the west, or remaining side, said lands are bounded by the large central irrigation canal . . . thus surrounded by water, it would not appear strange that his lands . . . should have produced alfalfa without the necessity of surface irrigation. That the lands of plaintiff were substantially benefited by percolating and sub-surface waters, can scarcely be doubted . . . there are other alleged elements of benefit which were considered by the triers of the facts in the order provided by the statute and we are not permitted to interfere with the findings of those tribunals unless the assessments appear to be arbitrarily or unreasonably made. Much must be left to the sound judgment and discretion of the officers appointed by law to determine the question of benefit in reclamation and drainage matters and finally to the court which makes a judicial review of the proceedings.

Purchaser of a Water Company Assumes Obligations of Service

The purchaser also assumes the additional obligation of development of a water supply if his predecessor so agreed.

In the case of Chrisman vs. Southern California Edison Co., 53 Cal. App. Dec. 364 (May 20th, 1927), the defendant, who had purchased a certain water system, refused to continue the old service or develop additional water as agreed to by its predecessor in interest.

In holding that the purchaser assumed all the liabilities and duties of his predecessor in interest, the Appellate Court states:

"When defendant purchased, as alleged, all of the property and property rights of Ventura County Power Company, including the water appurtenant to the land of plaintiff, it purchased said water subject to any existing rights to the use of said water. The right to water to be used for irrigation purposes is a right in real property. . . . The purchaser of a water distributing system is under obligation to continue to serve the consumers previously receiving service therefrom, even though he does not expressly assume that obligation.

The Owner of An Easement Is Bound to Maintain It

The law applies as well to ditches as to other rights of way.

In the case of Linton vs. Miller & Lux, Inc., (May 31, 1927) 53 Cal. App. Dec. 511, a complaint was filed by the plaintiff alleging that defendant was under the duty of maintaining a certain weir in its canal for the benefit of the plaintiff and not having done so plaintiff claimed damages caused through his inability to obtain water.

The trial court sustained a demurrer to the complaint, without leave to amend,

and in affirming this judgment the Appellate Court states:

"It is apparent that the contract does not support the allegations that Miller agreed to maintain and keep the weir in good condition and repair for the purpose of irrigating the plaintiff's lands. . . . We are satisfied that no stipulation of the contract places upon the defendant the burden of repairing or replacing the particular weir; on the other hand, there is no obligation placed by law upon the owner of a servient estate to repair or maintain a right of way or canal for the benefit of the dominant estate . . . and the rule in such cases was announced in the following language, 'The grantee, or owner of the easement, is bound to keep it in repair, and this applies as well to water ditches as to private ways' (citing cases) . . . In Prescott vs. Williams, 39 Am. Dec. 688, cited in Durfee vs. Garvey, 78 Cal. 546, it was said: 'The duty of making repairs, and the labor necessary for keeping the water course in a state fit for use, rests wholly upon him who claims an estate in his neighbor's land; and, as a general rule, easements impose no obligation upon those whose lands are thus placed in servitude to do anything.'"

Power Cost Two Million

Development of seasonal hydro-electric power at Elephant Butte Dam will cost $2,100,000, according to the report of Quinton, Code & Hill, Los Angeles, submitted by Louis C. Hill to members of the boards of the Elephant Butte irrigation district and El Paso County water improvement district No. 1.

The cost estimate includes the installation of a 25,000 kilowatt plant at the dam, a transmission line to a point near El Paso and a sub-station there.

"Even if the power company should absorb no more than the minimum guaranteed," says the report, "there would be a considerable surplus in excess of such operating expenses, interest on the bonds and sinking fund charges for authorization of the bonds."

The engineers also figured that the gross revenue for the period 1927 to 1953 would be about $390,000 a year. This estimate, it was stated, was based on the assumption that the load of El Paso Electric Company, the purchaser in this instance, would grow as anticipated.

La Habra Water Offer Refused

The La Habra Domestic Water Company has refused La Habra's offer of $120,000 cash for the water system. The city had hoped to become the owner of the plant which is now privately operated. The cash offer was made after an appraisal of the plant had been made by the city engineer, Paul D. Pratt. In refusing to sell at the price named, the water company states that the amount offered is not sufficient in view of the investment made by the company.

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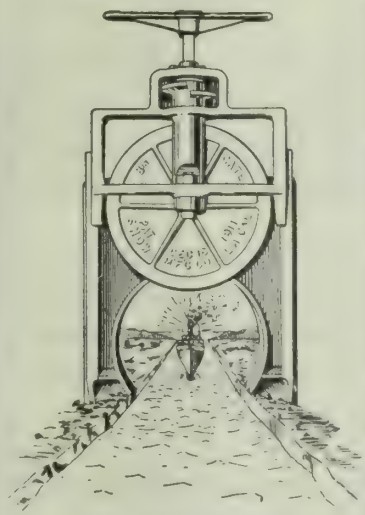

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Stream Flow Administration in Western States

(*Continued from Page 15*)

Mainly on this account in the last few years most of the adjudications have been handled through the court reference method. To accomplish this a suit is filed, sometimes a friendly suit, and then by stipulation the case referred to the Division of Water Rights. In this way rights of all classes, appropriative, riparian and prescriptive, are included as the court has jurisdiction over all such and the Division of Water Rights in acting as the court's referee can properly take account of all. The Division after making its investigations reports back to the court, often presents a suggested form of decree and the desired result, i. e. a workable adjudication of rights, is accomplished.

This method is not without its difficulties, however, as it is usually necessary to reframe the pleadings to the suit, so that all parties cross complain and to have the court order into the case all users of water from the stream in question not already parties to the suit. Therefore unless the judge and the various attorneys are actively interested in seeing that a true adjudication results some difficulty is apt to be encountered.

Adjudication Results

Adjudication proceedings on twenty streams in California have been undertaken by the Division of Water Rights—fifteen under court reference and five under the adjudication procedure provided in the statute. Nine have been completed and eleven are pending. While three stream systems of considerable magnitude, the Stanislaus, Shasta and Whitewater Rivers, are being adjudicated the other proceedings have been principally on smaller stream systems and also mainly in the northern part of the state. The increase in activity under the court reference method has been marked in the last few years.

Distribution

The first instance of distribution of water under the provisions of the 1921 statute occurred in 1922 when the water users on West Carson River, an interstate stream which flows into Nevada, petitioned for and received service in conformity with the law just passed. Since that time as additional adjudications have been completed the number of water masters has grown to six besides some assistants. No method of compensation being provided for it has been necessary for the water users to voluntarily subscribe the greater part of the required funds, the state lending some aid. This method is of course unsatisfactory and has retarded extension of water master service. As pointed out earlier this difficulty has now been removed with the adoption of what is believed to be an equitable method of payment for the water masters.

The necessity for a responsible official in charge of distribution has in some instances been so great that agreements have been entered into under which a water master could operate. In some such cases adjudications were under way but not completed and in others the complications of the situation were so great that adjudications by any method were deemed practical impossibilities and mutual agreements were reached among the ditch owners which permitted distribution. The outstanding example in this latter class is Kings River, the most important irrigating stream in California. Approximately 700,000 acres are irrigated with the waters of Kings River and the direct flow rights and diversion capacities extend up to 10,000 second feet, a flow which obtains in the ordinary season for a very few weeks and which is not reached in a dry season. One hundred and fifty thousand people, practically all dependent upon the results of agricultural pursuits, live in the area supplied by the waters of Kings River so that the importance of the matter is appreciated.

This river is an excellent example of the confusion caused by the conflict between the two principles of water rights. Over two hundred law suits had been filed affecting the water rights of Kings River and more than forty actual court decrees entered which, however, were so complicated and impossible of reconciliation that they could not be used as a basis for either adjudication or distribution. After several years of investigation a schedule devised along the lines of past use was suggested by the Division of Water Rights for Kings River and accepted temporarily by all parties. Under this schedule the water has been successfully distributed for a number of years.

A somewhat similar situation exists in Sacramento Valley which has the additional problem of the low lying lands around San Francisco Bay which are endangered by salt water entering from the bay. Formerly the flow of Sacramento River was sufficient to keep the salt water back but with the development of agriculture in the upper Sacramento valley this is no longer the case. A water master with very limited authority is in charge of Sacramento valley.

Speaking generally, both adjudication and distribution are in their infancy in California. As the advantages are demonstrated by the examples at hand there is a greater demand for such regulation

and if the riparian question could be satisfactorily adjusted there would, in the writer's opinion, be a development along these lines comparable to what has taken place in many of the other western states. California has not of course built up an organization similar to that of Colorado or Wyoming or Idaho. Its water master efforts so far have been more or less sporadic and of small consequence compared to other items of the Division of Water Rights' work. Many cases come up as emergencies for short times only and so far the work has not been large enough to warrant a separate organization. The time is approaching however, when this will have to be provided and we are glad to have available the experience and precedent of the other states who have studied these problems for so many years.

Herminghaus Decision

Returning to the most important question affecting California water rights, that of riparian rights, the state supreme court during the past twenty or thirty years had considerably narrowed this principle by limiting riparian areas and by, in some cases, insisting on actual need of water but in the latest case, that of Herminghaus vs. Southern California Edison Company, the court in a lengthy opinion made a sweeping declaration in favor of riparian owners stating among other things that the use of the full flow of a river in order to afford the natural diversion of a small part of its waters through overflow was a reasonable riparian use. In the particular case in question this meant that the flood flow of the San Joaquin River, 20,000 second feet, could be required for the natural irrigation of the Herminghaus lands while it was admitted that 180 second feet would be sufficient if artificial means of diversion were used. This principle would mean in effect that storage could not be made on a stream where a lower riparian owner demanded the full flow for the natural irrigation of his lands.

As on its face this decision appeared to make it possible for riparian owners to prevent upstream storage it has been widely discussed and solutions of various kinds have been advanced. The State of California has been for the past six years conducting investigations with a view to devising a plan for the most complete utilization of its water resources, the key note of such a plan being the storage of flood waters as the natural flow of the streams of the state during the irrigation season is already practically taken up. This decision then became of importance to the state itself in this connection. The

(*Continued on Page 51*)

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OVERHEAD IRRIGATION

Overhead Becoming Popular In Northern California

Several New Installations Recently Completed Increase Acreage Devoted to Spray Irrigation

By WILLIAM R. GARDNER, Jr.

THE overhead or spray method of irrigation is becoming quite popular in many districts of northern California. The Oroville-Wyandotte district, which comprises one of the richest citrus belts in the north, is located in a rolling country, which makes the furrow method of irrigation rather wasteful of water. In an attempt to find some better system, several overhead installations were made about three or four years ago, and the success which has attended these particular systems has been, to say the least, unusual.

In spray irrigation, the water is applied to the ground in the form of rain, or mist, so that the surface crops receive even distribution throughout the area covered by the spray. The first experiments in the Oroville-Wyandotte district were confined to small areas, two to three acres each, but during the past years, there have been several installations covering thirty to fifty acres each. The owners seem to be particularly pleased with the results, and plan to increase the area covered by the spray system next season.

Essential Features of Overhead System

The essential features of every system designed for overhead irrigation are the spray heads, feed pipes, and the pumping plant, or its equivalent. There are a great many different types of spray heads on the open market, some of which are adaptable for one purpose, but not suited for another. The system which seems to be the most popular, for field crops, consists of a series of nozzles inserted in parallel pipe lines, supported above the surface of the ground on posts in such a way that each line is fed from a main at one end, and irrigates a strip from 50 to 60 feet in width, the entire length of the field. However, most of the overhead installations are being made in orchards, where it has been found that this arrangement is impracticable. For orchards, the stationary type of overhead irrigation seems to be better suited. This consists of a system of equally spaced nozzles over the field, so that any portion can be irrigated by merely turning on the water. The feeder system forms a network of piping so constructed that the nozzles are about 30 feet from each other and staggered. This makes the circular areas covered by the nozzles fit together with the least amount of overlapping, and yet cover the bulk of the ground. These nozzles are placed upon ¾-inch risers 5 to 6 feet above the surface of the ground.

There are several different types of nozzles being used in the district, each of which appears to have certain features which make them better adaptable for certain classes of irrigation. Roughly, these heads, or nozzles, may be divided into the following groups. (a) Solid nozzles with no moving parts. (b) Adjustable nozzles, with parts which can be manipulated to change their capacities or degree of spray, (c) Rotary nozzles with moving parts which assist in the distribution of the water by centrifugal force.

Capacities of Spray Heads

The capacities of these nozzles seem to vary considerably. Under 20 pounds pressure, by actual test, the amount of delivery varied from 3.2 gallons to 14.5 gallons per minute. An additional 5 pounds head increased the output slightly, the same nozzles delivering from 3.5 to 18.4 gallons per minute. The areas covered by the different heads varied from 30 to 40 feet in diameter. The distribution of the water over these areas was not what could be called even, but it was sufficiently even for satisfactory irrigation purposes. Most of the nozzles delivered a relatively large percentage of the water in an annular ring from 10 to 30 feet in diameter, with gradual reductions of amount both inside and outside this ring.

The solid nozzles with no moving parts seem to be the most durable. Their capacities and form of spray cannot be varied as in the case of the adjustable nozzles. The solid nozzle seems to give a wide lateral throw of large capacity, but they also seem to demand larger feeder lines in order to maintain the delivery of this increased amount of water. Rotary nozzles throw the greater distance in proportion to their capacities, but in larger drops. A certain amount of wear also takes place, which in time reduces their efficiency to some extent.

Design of Feeder System

It has been found that the design of the feeder system has a great deal to do with the efficiency of the installation, and this design should be governed by the type of nozzle that is to be used. It has been found advisable to determine the type of system that appears to be the best adapted for the locality, and request that the company selling the nozzles perform the engineering work in connection with the installation. This has worked out very satisfactorily in the Oroville-Wyandotte district. Most of the manufacturers maintain a service department, which performs all of the engineering work in connection with any particular installation, and the irrigator is at liberty to call upon them to aid in the solution of his problems.

Plan Storage Reservoir

With plans for a project to irrigate 15,000 acres near Angels Camp, California, the Calaveras Water Users' Association, Inc., has applied to the state division of water rights for a permit to store 12,000 acre feet of water in Highland Creek.

Browning Has New Factory

The Browning Manufacturing Company have recently moved their plant and offices to their new factory, 513-515 Windsor Road, Glendale, California. The Browning Manufacturing Company, according to H. M. Pickering, sales manager of the company, have been unusually busy during the past season, and the move to their new quarters became necessary because of the great amount of increased business that has come to them during recent months. It was only a few years ago that the organizers started in business, manufacturing their sprinkler heads in a small room. Today the company has a modern factory, with over 5000 square feet of floor space, and outfitted with the most modern machinery.

Mr. Pickering has just recently competed a tour of inspection of all agencies handling the Browning equipment. During his trip he has covered over 5000 miles, visiting virtually every agricultural community in the Pacific Northwest. It is the opinion of Mr. Pickering that overhead irrigation is further advanced in California, than in any other section of the country which he visited, but finds that the overhead system is gaining wide recognition in other sections.

Stream Flow Administration

(Continued from Page 51)

recent legislature actively took up the question and considered many proposed constitutional amendments designed to clear the situation. After a hard battle in the legislature one such amendment was passed and will be voted on at the next general election in November, 1928. It is known as Assembly Constitutional Amendment No. 27 and provides that water rights in California of whatever character shall not exceed in amount that quantity of water reasonably required for beneficial use and shall not extend to requiring the flow of a stream in order to provide natural means of diversion. In other words this amendment is aimed directly at the doctrine declared by the Herminghaus decision.

Ask to Discontinue Service

Gore Brothers, Inc., has applied to the California Railroad Commission for authority to discontinue public utility water service in Tract 5644, Los Angeles County, the Los Angeles City Water Department now having its mains available for service in that Tract, and there being considerable complaint in regard to the service and quality of water supplied from the wells of applicant.

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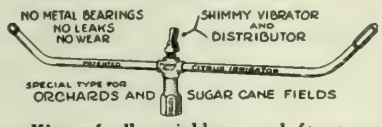

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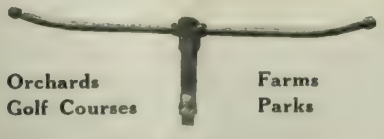

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SURVEY *of* HYDRAULIC DEVELOPMENT

A summary outline of developments contemplated on Western projects which have been announced during the month

Filtration and Chlorination

ABERDEEN, WASH.—Logging operations above the headworks of the domestic supply system have been started, according to reports from S. C. Watkins. Investigations are being made to ascertain if these operations might be polluting the water supplies. The extent of these logging operations may force a decision whether the city will install a filtration and purification plant at the headwaters.

Irrigation Development

FRESNO, CALIF.—An election was held Aug. 1st in the Foothill Irrigation District to vote on a $2,270 bond issue. L. J. Williams, secretary.

SANTA ANA, CALIF.—The Santa Ana Valley Irrigation Company have raised their rates in anticipation of a heavy construction program involving an expenditure of $30,000 for flood control and protection work.

VISALIA, CALIF.—The Kaweah Delta Water Conservation District being organized to serve a district including 350,680 acres, 84,000 of which are located in Kings county. An election will be called shortly. Geo. D. Smith is secretary and treasurer.

SALT LAKE, UTAH.—Representatives of the Sanpete County Water Users Association have been attempting to finance the Gooseberry irrigation project, which proposes to divert for use in north Sanpete 13,400 acre feet of water from the headwaters of Gooseberry Creek. It is estimated that the project will cost about $700,000.

CORONA, CALIF.—Two new irrigation districts have been formed in Orange County as the first step toward financing the proposed $600,000 storage dam across Santiago Creek above Orange County park. These districts were formed for the purpose of voting bonds to finance the water companies' share of the costs.

HEMET, CALIF.—Contemplating the placing of more than 1,000 acres of new land in the west end of the Hemet Valley under irrigation, the Fruitvale Mutual Water Company is soon to announce an expansion program calling for an investment of $50,000 for the drilling of new wells, a reservoir, and five miles of pipe line.

SALT LAKE CITY, UTAH.—The Daggett County Water Association has just proposed plans to irrigate 19,096 acres of land, diverting the water from Burnt Fork Creek. A large dam will be built, and several storage reservoirs at various points along the water shed of the supply streams. The firm of Caldwell & Richards are consulting engineers on the project.

EL CAJON, CALIF.—The valley water users have decided to guarantee their water supply by building several connecting pipe lines from the city to the Mesa Reservoir. At the present time the supply comes from a flume, and in case this flume should become damaged in any way, the city would have a shortage of water within twenty-four hours.

Pumping Equipment

OROFINO, IDAHO.—The city is planning the installation of a new pumping plant to supply the domestic and irrigation systems.

YAKIMA, WASH.—Construction of the Wapato pumping plant for 20,000 acres will go forward this summer, as a fund of $185,000 became available July 1st. L. M. Holt, supervising engineer for the United States irrigation service, is awaiting approval of the plans that he submitted for this work several months ago.

Reclamation and Drainage

COLTON, CALIF.—City Engineer C. A. Hutchinson has prepared preliminary sketches for converting Lytle Wash into a modern paved highway and flood control channel. The council has appropriated necessary funds.

ELLENSBURG, WASH.—The chief engineer's office of the U. S. Bureau of Reclamation has issued a call for bids for diamond drilling the proposed tunnel site across the Yakima River between Thorpe Prairie and the mouth of Swauk Creek. The original plans called for a steel syphon between these points, but the drilling operations will ascertain if a tunnel will be more feasible.

CALEXICO, CALIF.—Engineer Dowd of the Imperial Irrigation District has submitted maps and plans for the new drainage district, which will be financed by a bond issue, if the voters of the district approve the plans. It is estimated that the work will cost $1,380,000. While the directors have not definitely announced their plans regarding this new work, it is thought by valley engineers that it would be a serious mistake to stop the drainage program at this time.

FULLERTON, CALIF.—City Engineer C. M. Thorpe, and Trustees Annin and Smith have compiled a preliminary survey of a proposed storm drain project for the city of Fullerton. The project will probably be split up into two jobs, one in the eastern part of the city and the other intended to divert the Brea Creek flow through the Bastanchury Ranch and around the city of Fullerton. Total estimated cost of the two projects, $400,000. The latter project would require 1,200 ft. of tunnel, excavation, paving bridge construction, etc., The smaller of the two projects includes 600 ft. of 20-in. pipe to drain district north of the high school.

SALT LAKE CITY, UTAH—Until 2 p.m., August 9, bids will be received at the office of the Bureau of Reclamation, Salt Lake City, Utah, for furnishing labor and materials and performing all work for construction, comprising earthwork and structure, on the Weber River Division, Salt Lake Basin Project, Utah. The work includes the Echo Dam, and grading and structures for the relocated branches of the Union Pacific Railroad and the Lincoln Highway around Echo Reservoir, and is located near Echo, Utah, on the Park City branch of the Union Pacific Railroad. The principal items and the approximate quantities involved are as follows: 40,000 cu. yds. stripping for embank; 2,250,000 cu. yds. excavation; 1,700,000 sta. yds. overhaul; 14,000 cu. yds. concrete in structure; placing 750,000 lbs. reinforced steel; placing 2,500 lin. ft. concrete culvert pipe and 1,000 lin. ft. corrugated metal culvert pipe; installing 880,000 lbs. of structure steel and other metal work; and constructing 15,000 lin. ft. of highway guard rail and fence. This invitation for bids does not cover the purchase of materials, which are to be furnished by the Government. Materials furnished by the contractor and those furnished by the Government are described in the specifications. For information address the Bureau of Reclamation, Salt Lake City, Utah; Denver, Colo., or Washington, D. C.

Reservoirs and Dams

EL CENTRO, CALIF.—Imperial Irrigation District has received approval of secretary of war on application for permit to repair and rebuild its temporary diversion dam or weir in the Colorado River at or near Hanlon's Heading.

GARDENA, CALIF. — Gardena Heights Water Co. has abandoned idea of roofing a reservoir near Rosecrans Ave. with corrugated galvanized iron. The bids received, July 21, were repected.

GLENDALE, CALIF.—City public service department is preparing plans for a 50,000,000 gallon reservoir to be built on the property owned by the city at the north end of Campbell St. Estimated cost, $200,000. P. Diederich, public service manager.

SANTA BARBARA, CALIF.—Water Superintendent Victor E. Trace is completing plans for the enlargement of the Sheffield Reservoir to 50,000,000-gal. capacity, by raising the dam 25 ft. The reservoir will be relined with concrete.

GLENDORA, CALIF.—Until 8 p. m., Aug. 9, bids will be received by city trustees for re-roofing the city's water reservoir with composition roofing, in accordance with specifications on file at the office of the cityclerk, Fred Long.

LOVELOCK, NEV.—Lovelock Irrigation District did not receive any bids for the bonds of the district and has returned checks to bidders who submitted proposals for the construction of an earth-fill dam. An effort will be made to dispose of the issue in the open market. F. H. Tibbetts, Alaska Commercial Bldg., San Francisco, consulting engineer. King & Malone, Reno, district engineers.

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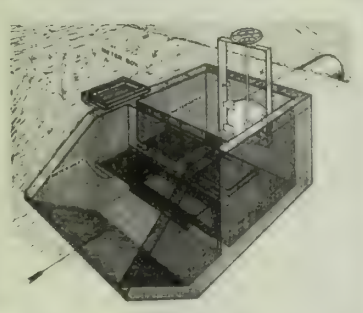

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SANTA BARBARA, CALIF.—Superintendent V. E. Trace has asked immediate approval of his plans for the enlargement of the Sheffield reservoir. At the time the enlargement takes place, the reservoir will be lined with concrete.

SAN DIEGO, CALIF.—It is estimated that the cost of the new Sutherland dam will greatly exceed the original estimate. One engineer placed the new figure at nearly double the amount bid by the contractors, Edwards, Wildey, & Dixon. The contractors' bid was $885,000.00.

CHEHALIS, WASH.—The voters of the city have been asked to vote upon the issuance of $80,000 in bonds, the proceeds from the sale of which will be used in the construction of a five million dollar reservoir near Dobson Park. There appears to be no opposition to the bonds.

GRASS VALLEY, CALIF.—The Nevada Irrigation District has authorized the preparation of plans and specifications for the proposed dams at Scott's Flat on Deer Creek, and Combie Crossing on Bear River. These plans are to be finished by August 26, 1927, and are being made by Fred H. Tibbetts, Inc., of San Francisco, Calif.

BURBANK, CALIF.—M. S. Ross, Hollywood Security Bldg., Los Angeles, was awarded contract by city, July 19, at $50,887.35 for constructing a reinforced concrete reservoir, storm drain, driveway, spillway, for the city water department. Plans by City Engineer T. R. Mini.

SANTA ANA, CALIF.—Villa Park and El Modeno have both voted to form water districts under the county laws. Elections will be held in these districts later to vote bond issues. The issues will be for $150,000 each. The Irvine Co. has promised $300,000 to be added to these district funds to erect a dam at the Fourth Crossing, above the Orange County Park.

OAKLAND, CALIF.—Atkinson Construction Co., Ray Bldg, Oakland, has been authorized by the East Bay Municipal Utility District to proceed with the construction of the Lancha Plana Dam in connection with the Mokelumne Project for a water supply for the East Bay cities. Litigation over the site has delayed the work. The contract, which was awarded in September, 1925, was for $3,081,378.

SEATTLE, WASH.—The city council has authorized Ambursen Dam Company to make plans for the dam on Gorge Creek. (See Modern Irrigation, June, 1927.) They also approved plans for a masonry dam across Diablo Canyon on the Skagit River. The development of this later project is now before the Board of Public Works, and in view of the decision just reached, it is contemplated that work on this structure will soon be under way.

Sewage Disposal

CORONADO, CALIF.—City manager has been directed by the trustees to investigate a proposal to construct a modern sewage disposal plant, estimated to cost between $30,000 and $35,000. T. H. Messer, city manager.

MAYWOOD, CALIF.—Proceedings for the construction of the Maywood sewer system will be started again following a ruling of Judge Shaw in the Superior Court restraining the trustees from proceeding with the work. The original proceedings were found to be faulty.

VENTURA, CALIF.—An executive plan of development has been announced by city council for the improvements to the water supply system, and the sewage disposal system. The expenditure has been estimated at $500,000. At the present time Ventura has no adequate water storage, and it is estimated that there should be constructed a reservoir of 10,000,000 gallon capacity, which would take care of one week's consumption.

SAN BERNARDINO, CALIF.—Contract with the Currie Engineering Co., Alhambra, for engineering services in connection with the new outfall sewer and disposal system has been approved by the city council. Final approval is scheduled for July 25. Chas. E. Johnson, former city engineer, is now associated with the Currie Engineering Co., and will have charge especially of the San Bernardino sewer project.

Waterworks

KENT, WASH.—The water committee has recommended the laying of a new four-inch pipe line and water main on Hazel street.

LONG BEACH, CALIF.—The city will proceed with all possible speed to install new water mains in the Belmont Shore and Naples districts.

MONROVIA, CALIF.—To enable the extension of the city's gridiron water distributing system, the city council has authorized the sale of $195,000 worth of bonds.

RENTON, WASH.—The Springbrook watershed is to be developed by the city for a domestic water supply. The plans contemplate considerable expenditure, nearly doubling present supply.

VAN NUYS, CALIF.—Joseph Tanner, manager of the Ventura Boulevard Chamber of Commerce, has announced that plans are under way for extending water service mains to the district which runs west from Stone Canyon to Girard.

COMPTON, CALIF.—Plans have been authorized by the city trustees for a sanitary sewer system in Belle Vernon Acres, involving 15,000 lin. ft. of 8-in. vitrified main sewers, with brick manholes, flush tanks, etc.; 1911 act. Glen Rood, city engineer.

PLACENTIA, CALIF.—Negotiations have been completed for the sale of the Placentia Domestic Water Company to A. S. Bradford, a wealthy oil man of the city. Mr. Bradford contemplates immediate expansion of the system, so as to supply a town of 5,000.

SIGNAL HILL, CALIF.—Plans are being formulated for the issuance of bonds for the financing of a water supply system for the city of Signal Hill. The system will come under municipal ownership, and the advocates of the system promise lower rates under the new regime.

SAN DIEGO, CALIF.—City manager Lockwood has been instructed by the council to send experts to Encanto for the purpose of estimating the cost of a 100,000 gallon standpipe, replacing some of the smaller water mains with larger ones, and providing means to control local flood conditions during the winter months.

SANTA BARBARA, CALIF.—Water superintendent V. E. Trace has been authorized by the city council to proceed with a survey of the Mono dam project. Appropriations of $10,000 have been made for this work. The project calls for the construction of a dam above the Gibraltar reservoir, the possible raising of Gibraltar dam, building check dams on the streams entering Gibraltar and Mono reservoirs, and a tunnel connecting Santa Ynez mountains with Mono dam.

For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

POMONA, CALIF.—The voters of Narod are being asked to ratify a $60,000 bond issue, the money to be used in installing a new domestic water system. At the present time Narod is securing domestic water from Pomona and Ontario, with what is considered inadequate fire protection because of the lack of sufficient water.

PORT TOWNSEND, WASH.—It appears that the city will shortly be faced with the necessity of entirely rebuilding the Olympic gravity water system, in order to maintain the continued rate of consumption. This additional construction will have to be met in the near future, and it is expected that an increase in rates will be inaugurated shortly in anticipation of the expansion.

OLYMPIA, WASH.—The city commissioners have taken the first step for the establishment of a new water supply system for the city. They appointed a committee of citizens who will investigate and study conditions, including the four proposals outlined by other hydraulic engineers, including the Skookumchuck, Satsop, and the McAllister.

LOMITA, CALIF.—Engineer Wm. Davidson of Los Angeles has advised the citizens' committee of Lomita that a new water distribution system is necessary for the welfare of the city, and in a letter to H. S. Tregarthen, advised plans for this system, advocating individual services for every lot, thereby eliminating future expense of tearing up the streets to make connections.

ABERDEEN, WASH.—Bids have been requested for the purchase of bonds recently voted for the new industrial water supply of the city. The total issue is $1,600,000, and the council voted to offer such portion as would be required to bring the water to Aberdeen and Junction City, after a proviso had been added, stating that bids would not be accepted until such time as the city had signed contracts for the delivery of enough water to insure the ultimate success of the project.

HUNTINGTON PARK, CALIF. — City trustees and Fire Chief Jack Tinsley are considering a proposal to install additional fire hydrants for a more complete fire protection system, especially at the high school site where but 175 gals. per minute are now available, with 1,000 gals. per minute necessary to successfully protect the institution. The city officials will confer with the trustees of the school and the Huntington Beach Water Co. as to the necessary pressure and the location of the new hydrants.

Unit Bids

COOLIDGE DAM, ARIZ. — Pratt-Gilbert Hardware Co., Phoenix, has been awarded contract by C. H. Shotwell. special disbursing agent, for furnishing approximately 32 carloads of reinforcing steel for use in the construction of the Coolidge Dam. Shipments will start as soon as possible from Minnequa, Colorado.

ARCADIA, CALIF.—E. M. Funk, Diamond St., Arcadia, and Fred S. Northrupp apparently submitted two low bids to city July 6 for excavating, laying, flooding and backálling for about 11,720 ft. 6-in., 8-in. and 10-in. pipe. The bids were referred to the city engineer and the water supt. for tabulation and report July 13. The bids follow:

E. M. Funk—(1) 10-in., $750; (2) 8-in., $315; (3) 6-in. $2,529.

Fred S. Northrupp—(1) $810, (2) $301, (3) $2,567.68.

L. D. Loomis—(1) $780, (2) $336, (3) $2,726.40.

Adams Pipe Works—(1) $1,260, (2) $490, (3) $3,946.

Geo. Mitchell & Co.—(1) $1,770, (2) $728, (3) $5,572.40.

C. E. Ulrich Co.—(1) $1,200, (2) $462, (3) $3,711.60.

H. E. Adams—(1) $990, (2) $462, (3) $3,465.

Edgeley Co.—(1) $864, (2) $355.60, (3) $2,786.08.

Thos. Haverty Co.—(1) $1,770, (2) $686, (3) $5,091.20.

LOS ANGELES, CALIF. — (Old River School Road Trunk Sewer—County San. Dist. No. 2)—John Artukovich, 684 E. 50th St., was awarded contract by County Sanitation District No. 2, at $57,923.75 for constructing the Old River School Road trunk sewer from the So. Pac. Ry. to District No. 2 main trunk sewer, involving (1) 9,315-ft. 18-in. vit pipe sewer at $5.25 ft., (2) 2,148 ft. class "C" bedding at $2.50 ft., (3) 250 cu. yds. gravel bedding at $2.90 yd., (4) 25 manholes at $100 ea. (5) 5 jct. cham. at $105 ea. Other total bids follow: Dalmatin and Nikcevich, $59,009; Geo. A. Shepard, $60,185.95; Mlagenovich & Gillespie, $63,388; Thos. Haverty Co., $63,653.75; J. C. Hickey, $65,476.30; Mike Vukojevich. John Herceg and C. Vukojevich, $70,524.25. Other unit bids follow:

Dalmatin & Guho—(1) $5.68, (2) $1.35, (3) $3, (4) $80, (5) $90.

Geo. A. Shepard—(1) $5.73, (2) 75c, (3) $6, (4) $140, (5) $140.

Mlagenovich & Gillespie—(1) $6, (2) $1, (3) $10, (4) $95, (5) $95.

Thos. Haverty Co.—(1) $6.05, (2) $1, (3) $5.50, (4) $125, (5) $125.

J. C. Hickey—(1) $6.42, (2) 50c, (3) $4, (4) $120, (5) $120.

LOS ANGELES, CALIF.—(Keswick Ave.)—Leo Miletich, 610 W. 54th St., submitted the low bid to board of public works, July 25, at $37,255.98 for constructing a sewer in Keswick Ave. between Fox Hills Dr. and Beverly Glen Blvd., involving the following quantities:

(1) Constructing sanitary sewer, complete;
(2) 7,577 lin. ft. house connection sewers;
(3) 343 sq. ft. class A resurfacing;
(4) 325 sq. ft. class D resurfacing;
(5) 317,670 sq. ft. scarifying and oiling.

The bids were:

Leo Miletich—(1) $22,383, (2) $1.10, (3) 16c, (4) 40c, (5) 2c; total, $37,255.98.

Martin Simunovich—(1) $22,475, (2) $1, (3) 5c, (4) 30c, (5) 2.5c; total $38,142.70.

Frank H. Brigham—(1) $21,590, (2) $1, (3) 12c, (4) 40c, (5) 3c; total $38,868.26.

J. C. Hickey—(1) $24,700, (2) $1, (3) 10c, (4) 25c, (5) 2.5c; total $40,334.30.

Bob Basnyak—(1) $24,000, (2) $1, (3) 14c, (4) 30c, (5) 3c; total, $41,272.62.

Geo. W. Kemper—(1) $25,700, (2) $1, (3) 15c, (4) 40c, (5) 2.5c; total $41,400.

M. N. Guho—(1) $23,900, (2) $1.10, (3) 20c, (4) 40c, (5) 3c; total, $41,963.40.

Harmon Co.—(1) $27,732.38, (3) 81c, (3) 15c, (4) 35c, (5) 3c; total $43,565.05.

Leo Vuksevich—(1) $30,000, (2) $1.20, (3) 15c, (4) 30c 2c; total, $45,594.75.

Contratto Bros.—(1) $29,425.14, (2) $1.10, (3) 20c, (4) 30c, (5) 3c; total $47,456.04.

J. D. Harms—(1) $29,963.17, (2) $125, (3) 12c, (4) 55c, (5) 3c; total $49,184.43.

Chutuk, Kordich & Vukojevich—(1) $32,-899.50, (2) $1.50, (3) 14c, (4) 40c, (5) 3c; total, $53,973.12.

Gogo & Rados—(1) $36,000, (2) $1.25, (3) 18c, (4) 30c, (5) 2.75c; total, $54,366.41.

OAKLAND, CALIF.—Geo. G. Pollock Co., Forum Bldg., Sacramento, submitted low bid to East Bay Municipal Utility District, July 15, at $1,370,685 for the construction of Lafayette Dam, to be rolled earth-fill type

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with puddled clay core, 170 ft. maximum height, 1,855 ft. crest length, with 6-in. concrete face. Work involves 2,200 cu. yds. concrete cut-off, 6,000 cu. yds. waste excavation (spoil banks), 45,000 cu. yds. puddle trench fill, 1,887,000 cu. yds. embankment in place, 17,500 cu. yds. small broken rock or screened gravel covering in place, 10,000 cu. yds. reinforced concrete payment, 1,000 cu. yds. overhaul of embankment, 2,800 lbs. metal (concrete conduit and pipes), 25,000 cu. yds. excavation (conduits), 20,000 bbl. portland cement, 800,000 lbs. reinforcing steel in place, 2,600 cu. yds, reinforced concrete in place, 1 check valve in place, 6 slide gates in place, 6 metal trash racks in place, metal ladders, landings, floor plates, I-beam grillage, hoist supports and screens in place, 5 sets of glazed steel window sash in place, 1 wooden door complete, 5,200 lin. ft. 6-in. vitrified drain tile, 1,000 ft. 8-in. vitrified drain tile. The next low bidder was Kaiser Paving Co., Oakland, $1,407,000; A. Guthrie of Portland was third at $1,500,000. Fourteen bids were received, four bids being below the estimate. Bids were taken under advisement by Chief Engineer Arthur P. Davis. Other bids were: Kaiser Paving Co. $1,407,100; A. Guthrie & Co., Portland, $1,419,000; Youdall Construction Co., $1,482,600; Henry & McFee Construction Co., $1,539,720; Twohy Bros., & J. F. Shea, $1,544,878; Ward Eng. Co., San Francisco, $1,560,230; D. McDonald, Sacramento, $1,574,280; Utah Construction Co., San Francisco, $1,593,065; F. Rolandi, San Francisco, $1,648,418; Sharp & Fellows Construction Co., $1,723,804; Winston Bros. Co., Minneapolis, $1,732,828; C. R. Adams, Yreka, $1,779,680; Jasper-Stacy Co., San Francisco, $1,799,205.

LOS ANGELES, CALIF.—(Douglas Ave. Trunk—Co. San. Dist. No. 2)—Chutuk, Kordich & Vukojevich, 860 Main St., El Segundo, were awarded contract by County Sanitation District No. 2 July 13, at $9,506.75 using vitrified pipe for constructing a portion of Douglas Ave. trunk sewer extension from a point in Arizona Ave. north of Anaheim Telegraph Road to the junction of 6th St. and Burger Ave. Work involves (1) 2,120 ft. 8-in. at $1.23 for cem. and $1.23 for vit. pipe, (2) 875 ft. 10-in. at $1.35 for cem. and $1.35 for vit., (3) 2,290 ft. 12-in. at $1.70 for cem. and $1.70 for vit., (4) manholes at $80 ea., (5) 11 jct. cham. at $85 ea., and (6) one drop manhole at $100. Other total bids: Harmon Co., $9,200.75 cem., $10,218.60 vit: Frank H. Brigham, $10,170.55 cem., $10,451.75 vit; Gogo & Rados, $10,403 cem., $10,403 vit.; S. M. Milovich, $10,709.42 cem., $10,918.54 vit; Mike Vukojevich, John Herceg and C. Vukojevich, $10,756.25 cem., $10,756.25 vit; Joseph Zelko, $11,077.75 cem., $11,137.65 vit; Leo Vuksich, $11,738.95 cem., $11,867.55 vit; John Brkich, $12,391.25 cem., $12,018.50 vit.; Thos. Haverty Co., $14,248.75 cem., $14,248.75 vit; Mlagenovich and Gillespie, $19,600 cem., $19,825.81 vit. Other unit bids follow:

Harmon Co.: (1) $1,105, $1.13, (2) $1.27, $1.46, (3) $1.67, $2.01, (4) $82.20, (5) $90.60, (6) $114.

Frank H. Brigham: (1) $1.25, $1.28, (2) $1.55, $1.59, (3) $1.67, $1.75, (4) $105, (5) $105, (6) $135.

Gogo & Rados: (1) $1.50, $1.50, (2) $1.60, $1.60, (3) $1.70, $1.70, (4) $85, (5) $90, (6) $90.

S. M. Milovich: (1) $1.54, $1.58, (2) $1.66, $1.70, (3) $1.76, $1.80, (4) $90, (5) $92, (6) $98.

Mike Vukojevich, John Herceg, and C. Vukojevich: (1) $1.50, $1.50, (2) $1.50, $1.50, (3) $2, $2.25, (4) $80, (5) $85, (6) $90.

Joseph Zelko: (1) $1.45, $1.47, (2) $1.53, $1.55, (3) $2, $2 (4) $93, (5) $95, (6) $110.

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Leo Vuksich: (1) $1.47, $1.49, (2) $1.77, $1.79, (3) $2.22, $2.25, (4) $90, (5) $90, (6) $100.

John Brkich: (1) $1.80, $1.75, (2) $1.95, $1.90, (3) $2.10, $2, (4) $90, (5) $95, (6) $115.

Thos. Haverty Co.: (1) $2, $2, (2) $2.05, $2.05, (3) $2.50, $2.50, (4) $110, (5) $115, (6) $125.

Mlagenovich & Gillespie: (1) $3, $3, (2) $3.25, $3.30, (3) $3.75, 3.80, (4) $85, (5) $85, (6) $85.

LOS ANGELES, CALIF. — (Portion of Joint Outfall Sewer, Unit No. 3, County San. Dist. No. 2)—Ross Construction Co., Van Nuys Hotel, was awarded contract by County Sanitation District No. 2, July 13, at $214,800 for constructing that portion of the joint outfall, unit No. 3, extending from Wilmington St. to Rocha St., involving 2,239 ft. 60-in. special heavy reinf, concr. pipe at $17.50 ft., 557 ft. 9-ft. 6-in. section A reinforced concr., type 1, at $40 ft., 4,228 ft. 9-ft. 6-in. reinf. concr. section B, type 1, at $34.45 ft., 64,598 sp. ft. sand, sulphur, and silica joint compound at 7c sq. ft., one manhole at $150, four special manholes at $350 ea., and one transition chamber at $1,611.04. Other total bids follow: Herbert M. Baruch Corp. and R. E. Cooney, $21,687.33; R. A. Wattson, $222,606.82; Chas. and Geo. K. Thompson, $229,469; Dalmatin & Nikcevich, $230,361.99; The Callahan Constr. Co., $246,928.71; Thos. Haverty Co., $263,540.50; Robert Metcalf, $270,659; Martin Simunovich, $295,985.50. Other unit bids:

Ross Constr. Co. (unit prices including alternates)—(1) 2,239 ft. 60-in. special heavy reinf. concr. pipe at $17.50 ft. (2) 9-ft. 6-in. section A, reinf. concr., type 1, at $40 ft; (3) alt. to (2), type 2, at $45 ft.; (4) 4,228 ft. 9-ft. 6-in. section B, type 2, at $34.45 ft; (5) alt. to (3), type 2, at $41 ft.; (6) sand, sulphur, etc., 7c sq. ft.; (7) manholes, $150 ea.; (8) special manholes, $350 ea.; (9) transition chamber, $1,611.04

Herbert M. Baruch Corp., and R. E. Cooney—(1) $18.50, (2) $36, (3) $45, (4) $34.75, (5) $43.75, (6) 8.5c, (7) $200, (8) $400, (9) $1,000.

R. A. Wattson—(1) $16.50, (2) $39.10, (3) $43.45, (4) $36.60, (5) $41, (6) 9c, (7) $242, (8) $423, (9) $1,392.

Chas and Geo. K. Thompson—(1) $16.50, (2) $44.50, (3) $48, (4) $37.50, (5) $43.50, (6) 9c, (7) $125, (8) $417, 9) $1.575.

Dalmatin & Nikcevich—(1) $19.60, (2) $42.55, (3) $49.55, (4) $36.05, (5) $41.05, (6) 8c, (7) $800, (8) $800, (9) $1,200.

The Callahan Constr. Co.—(1) $16.22, (2) $47.70, (3) $52.50, (4) $41.30, (5) $46.06, (6) 8.5c, (7) $156, (8) $620, (9) $1,300.

Thos. Havery Co.—(1) $19.25, (2) $48.35, (3) $53.20, (4) $43, (5) $47.45, (6) 10c, (7) $335, (8) $715, (9) $1,950.

Robert Metcalf—(1) $17.08, (2) $43.13, (3) $47.24, (4) $41.51, (5) $45.85, (6) 8.5c, (7) $150, (8) $250, (9) $500.

Martin Simunovich—(1) $19, (2) $60.50, (3) $67.80, (4) $46.25, (5) $50, (6) 5c, (7) $150, (8) $150, (9) $300.

Ramona Soon to Have Water

The distribution system of the Ramona irrigation district, California, is being rapidly completed. Concrete is being poured in the sump, and the big redwood tank has been installed on Ramona Hill. It is expected that water will be turned into the mains before the end of July.

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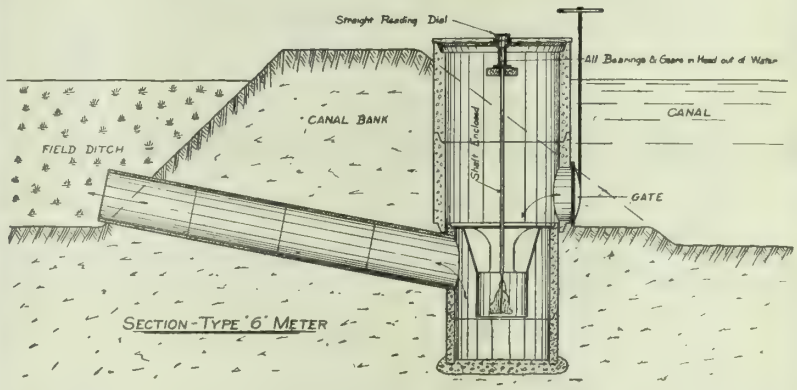

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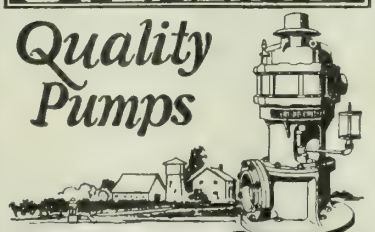

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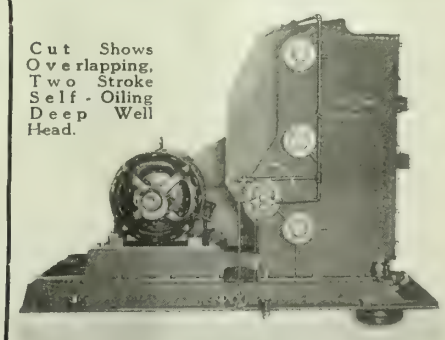

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WHO'S *WHO* AND WHO'S *WHERE*

IN THE WORLD OF HYDRAULICS

Personal Notes and Impersonal Observations About Men You Know

F. H. Henshaw, district engineer of the United States Geological Survey, was a recent visitor on the Klamath project, Oregon.

Rhea Luper, state engineer of Oregon, and B. E. Hayden, reclamation economist, made an inspection trip to the Vale project in July.

Alexander Bell, Pacific Coast manager of Wallace & Tiernan Company, Inc., with headquarters in San Francisco, was a recent visitor in Los Angeles.

Alan B. Sheldon, of the Denver office of the Bureau of Reclamation, has been transferred to the Kittitas division of the Yakima project, Washington.

Reid Jerman, assistant state engineer of Utah, has been directing the tabulation of irrigated areas, reservoir sites, and diversions from the Colorado basin for the Utah water storage commission.

W. D. Wood has been employed at the Gibson dam, Sun River project, Montana, to take charge of the concrete testing laboratory and to act as concrete inspector.

P. W. Dent, former assistant to the commissioner, has been appointed assistant commissioner of the Bureau of Reclamation. He will continue in charge of the legal work as chief counsel.

Frederick T. Mavis, Urbana, Illinois, has been awarded one of the Freeman travel scholarships in hydraulic engineering, providing a year's travel and study in Europe, beginning with July, 1927. Mr. Mavis has been a research assistant at the University of Illinois and more recently has been making a special study of flood control in the Illinois and Mississippi River valleys.

J. H. Jacobsen, crop statistician of the United States Department of Agriculture, with headquarters at Boise, Idaho, recently visited the Burley office of the Minidoka project, Idaho, to check up on crops.

A. W. Cuddeback, of New York City, vice-president of the Federal Water Service Corporation paid a recent visit to the Pacific Coast for the purpose of inspecting several water systems lately acquired by the corporation.

C. W. Wood, junior engineer with the Bureau of Reclamation, has been transferred from the Guernsey Dam, North Platte project, to the Kittitas division of the Yakima project, Washington.

Ray P. Teele, Porter J. Preston, and Charles A. Engle, who are making an engineering and economic survey of reclamation and Indian irrigation projects, spent several days studying the Okanogan project, Washington.

E. J. Bell, Jr., of the agricultural college at Bozeman, Montana, with County Agent Clarkson, made a recent trip to the Sun River project to learn the details regarding the economic survey that is to be made of the irrigated farms on the project.

R. E. McDonnell, of the engineering firm of Burns, McDonnell and Smith of Kansas City and Los Angeles, and president of the Kansas City Engineering Club, has been making a tour of the various Pacific Coast cities in which his firm has interests.

J. L. Sternfield, who represents the Sterling Pump Company in South America, with offices in Buenos Aires, Rio de Janeiro, Santiago and Lima, made a recent visit to the home office of the company at Stockton, California.

C. Edmond Dorisy, of Seattle, has been called in consultation by the city engineer's office of Hoquiam, Washington, with reference to proposed additions to the Hoquiam water system. Mr. Dorisy was state health engineer of Washington for seven years and during that time inspected water systems all over the state. He is a graduate of the University of Paris.

A. J. Wiley, of Boise, Idaho; D. C. Henny, of Portland, Oregon, and W. H. Nalder, of the Denver office of the Bureau of Reclamation, have been appointed a board of consulting engineers on the Owyhee, Deadwood and Gibson dams. Associated with them in the consideration of the respective dam sites will be the following: at Owyhee, F. A. Banks, construction engineer; at Deadwood, R. F. Newell, project superintendent, Boise project; and at Gibson, George O. Sanford, project superintendent, Sun River project, and Ralph Lowry, construction engineer.

Dr. Elwood Mead, commissioner of the Bureau of Reclamation, sailed on July 31 from New York for Palestine, where he went as advisor to the Zionist Organization of America. In 1924 Dr. Mead visited Palestine for the purpose of surveying the possibilities of reclaiming its land. Since that time scientists and economists from both the United States and the British Empire have been investigating the advisability of reclamation there, and their data will be available for him upon his arrival. Scientists from California are predominant among those now studying the Palestine situation, according to Dr. Mead, for California is similar climatically to Palestine, and the red soil bordering the Mediterranean is the same kind of red soil in which oranges are being cultivated in California. Dr. Mead has been granted a two months' leave of absence by the Department of the Interior and expects to stop in England and possibly in Italy for study of land settlement in those countries.

CALIFORNIA

MODERN Irrigation

Incorporating Western Waterworks

Vol. III SEPTEMBER, 1927 No. 9

SAN JOSE HOST TO WESTERN WATERWORKS FRATERNITY DURING ANNUAL CONVENTION

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Description of Bull Run Dam
by D. C. Henny

The Mokelumne River Project
by A. P. Davis

Columbia River Irrigation Project
by R. K. Tiffany

Chlorinating Sulphur Water
by Ray L. Derby

Transmission and Delivery of Water
by G. Clyde Baldwin

Riverside's New Water Supply Line
by Edward R. Bowen

The Use of Turbine Pumps
by Robert Schurman

Semi-Elliptical Sewage Pipe
by A. K. Warren

Program and Activities of the Convention

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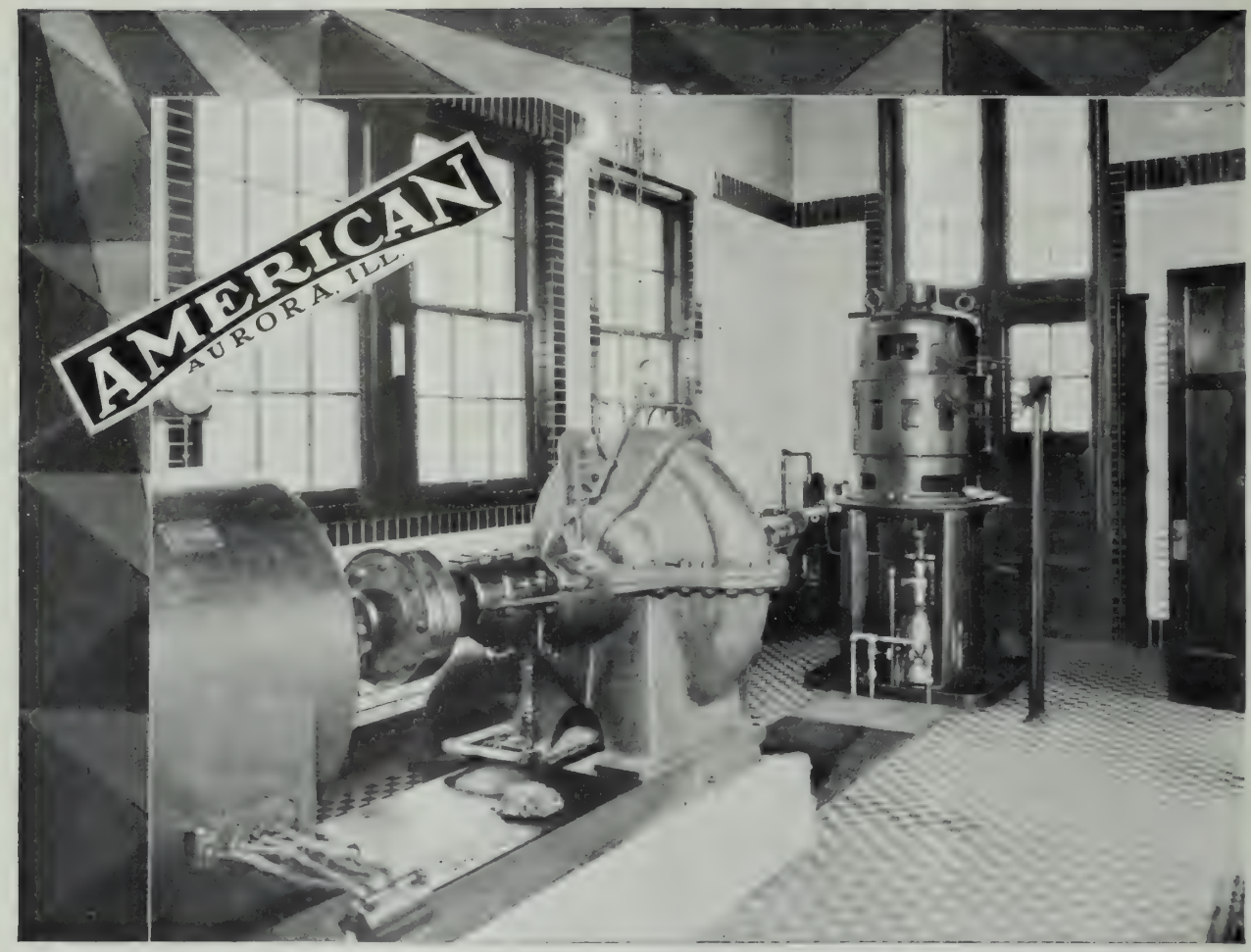
An Organized Voice for the Forces of Agriculture and Industry Which are Primarily Dependent Upon Irrigation



"American" Pumps at Sioux City, Iowa

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THERE are four stations upon which Sioux City, Iowa, depends for its municipal water supply.

Above is pictured the interior of one of these stations, which is typical of the four. Station number four has for pump equipment an "American" deep-well turbine with a capacity of 1600 G. P. M. when pumping against a total head of 85 feet at a speed of 1155 R. P. M. This turbine is driven by a 170 H. P. vertical slip-ring motor and pumps directly into the suction of the "American" 8-inch two stage horizontal split shell centrifugal pump shown in the foreground. This horizontal pump is driven by a 150 H. P. horizontal slip-ring motor.

Station number one was installed in 1915 and station number four, pictured above, was installed in 1922. All of the four stations are equipped with "American" pumps.

THE AMERICAN WELL WORKS

General Offices AURORA, ILLINOIS *and Factory*

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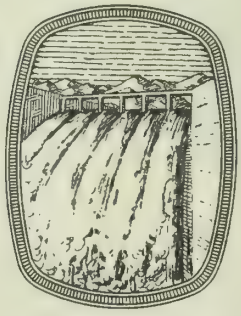
PETROLEUM WORLD 819 SANTEE ST., LOS ANGELES, CALIF. MODERN IRRIGATION

"Western Waterworks" Begins on Page 33

S. B. MORRIS

Chairman of the California Section of the American Water Works Association, which is holding its annual convention at San Jose October 5, 6, 7 and 8. Mr. Morris has been prominently connected with the waterworks industry for a number of years, during which period he has taken a great interest in the affairs of the waterworks society, having previously occupied the offices of secretary-treasurer and vice-chairman.

MODERN Irrigation
The Magazine of Applied Hydraulics



Volume III SEPTEMBER, 1927 Number 9

Guardians of Our Water Supplies

IT IS the usual custom for this department of the magazine to report the monthly progress in the field of irrigation and hydraulics, but at this time it seems fitting that no little space should be devoted to the progress and activities of the American Waterworks Association, especially since the California Section is about to hold their eighth annual convention. This meeting will take place at San Jose, California, the dates being set as October 5th to 8th inclusive.

The members of the American Waterworks Association consist primarily of men engaged in the operation and maintenance of the waterworks systems in the various cities and communities throughout the country, and the California Chapter applies directly to the state in which it functions. Few people realize that a waterworks plant is one of the chief assets of a city; in value it ranks well toward the top of all the municipal investments, whether a public or privately owned enterprise. The success and continued operation of all other industries, factories, and the numerous activities within the limits of its service, are entirely dependent upon the continued operation of the waterworks plants. The health, growth, and prosperity of the community served are also directly dependent upon the purity and cleanliness of its water supply. The systems extend over the entire city; the commodity is standardized and of but one quality.

PAUL E. MAGERSTADT
Secretary-Treasurer

On the Pacific Coast

"Western Waterworks" Begins on Page 33

JOHN BURT
Member Executive Committee

it is especially true, that the business of supplying cities with their domestic and industrial water supplies is very closely related to the business of supplying the agricultural districts with irrigation water. In a great many instances, the two go hand in hand, and we find many waterworks systems whose primary existence is for the purpose of supplying irrigation water, yet wholesale water to nearby towns to be used for domestic consumption. Irrigation systems and waterworks systems are oftimes so interrelated in this manner that it is rather difficult to distinguish the primary purpose of the organization.

The average layman takes for granted that he is supplied with pure, clean, wholesome water, and seldom gives a thought to the behind-the-scene organization which makes possible this necessity of life. Little does he think of the enormous amounts of labor and planning that has made possible the delivery of this water into his home, and which is always there, awaiting his demand.

From the waterworks department he secures the cheapest service rendered by any public utility, while at the same time immediate and insistent complaint arises if the service is suspended even momentarily. It is rather taken for granted that interruptions in electrical or gas service may arise from time to time and little, if any, comment is made, but a pected to be the nearest approach to perpetual motion that has yet been devised.

The duty of maintaining a pure and clean water supply, especially for the domestic consumers that the company serves, is vested with the waterworks superintendent, and his ability for performing this most important task is greatly measured by the results that are obtained. In order to better serve in his professional capacity, he must constantly add to his store of knowledge concerning modern waterworks practices, and this information can only be obtained by comparing his individual problems with those of men engaged in the same line of endeavor. It was for this purpose that the American Water Works Association was organized, and it was through the same interest that the California Section came into existence and continues to grow.

The California Section of the American Water Works Association is but yet in its infancy. In 1920 there was recorded a membership of 75, and the latest figures for 1927 show a membership of 220. When one stops to realize that in each and every small community throughout the entire state there is seldom more than one potential member, and that the larger cities can contribute but few more in proportion to their size, the growth of the Section might be considered an extremely healthy one.

P. DIEDERICH
Member Executive Committee

"Western Waterworks" Begins on Page 33

Completion of Bull Run Reservoir Will Double Present Water Supply of Portland, Oregon

Structure Rising 200 Feet Above Bedrock Will Be Ready by 1929. Features Use of Center Spillway with Specially Designed Section.

By D. C. HENNY
Consulting Engineer, Portland, Oregon

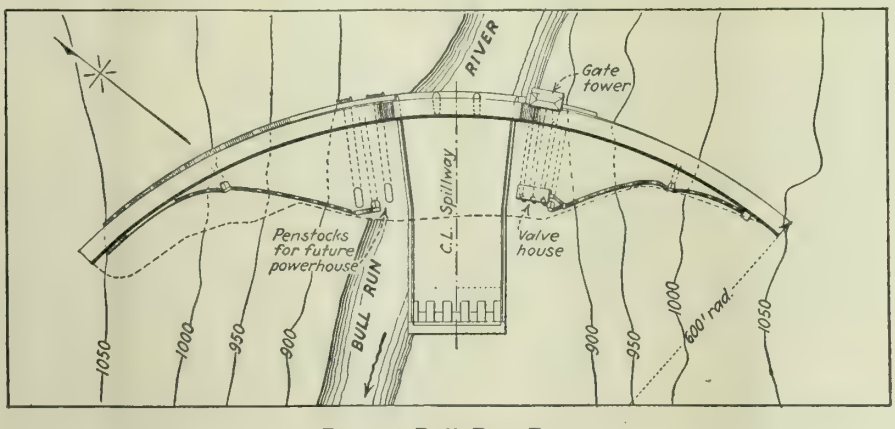
THE Bull Run Storage project of the Portland Water Department consists of a series of reservoirs on Bull Run River, the first of which is now under construction. It will hold 31,000 acre feet, a quantity sufficient to safeguard Portland against water shortage up to the time its high summer consumption shall have increased 2.13 times. The population now being supplied with water inside and outside the city is estimated by the Water Department at 395,000.

The dam is located below the junction of Bear Creek and Bull Run River at a point five miles above the diversion dam from which the three pipe lines to the city are supplied. It lies 28 miles by air line due east of the center of the city. By road the distance is 36 miles. An electric railroad reaches to within 10 miles of the dam.

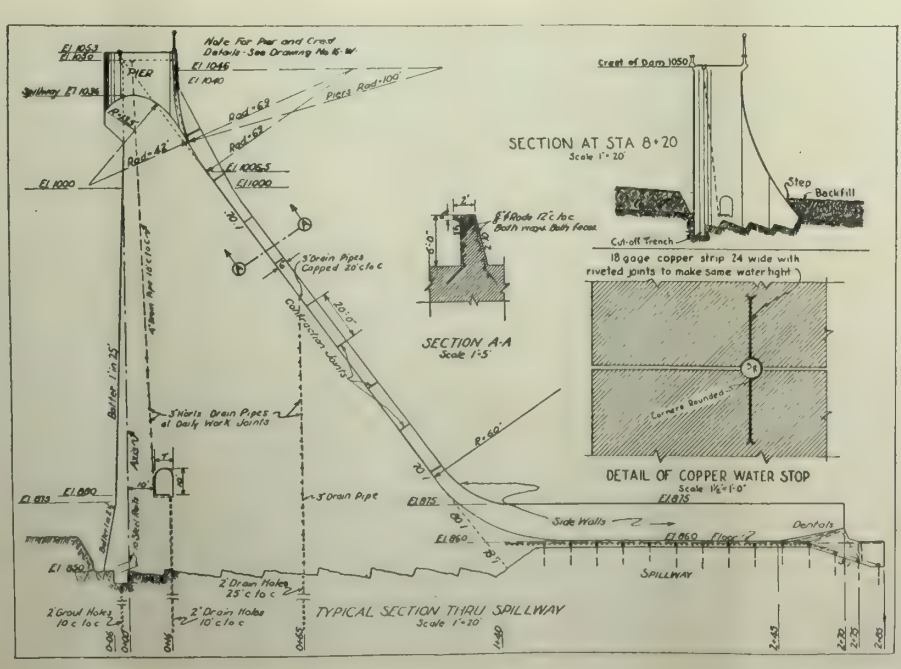
The dam will be 200 feet high above bedrock, and will contain 230,000 cubic yards of concrete. It is to be finished to a height of 120 feet ready for storage by May 1, 1928, and is to be entirely completed by December 31, 1928. It is of gravity design and curved in plan to a radius of 600 feet. Its length on top is 925 feet. Its water face has a batter of 1 in 25 from a point 50 ft. below the top of the dam downward and a back slope of 0.7 to 1 flattened slightly below the level of submergence. The maximum compressive stress at the heel is 188 pounds per square inch and near the toe 300 pounds per square inch on the assumption of 1 cubic foot of concrete weighing 148 pounds per cubic foot. Actual weight is found to be about 5 per cent greater.

Excellent Foundation

The foundation is hard blue lava which occurs in different flows with slightly sloping planes of separation. The planes of contact are generally tight. Seams, however, occur as is evidenced from an artesian flow developed in diamond drill boring at depths below the top of valley floor bedrock ranging from 25 to 60 feet. Upon first striking this flow it developed a pressure of 75 pounds per square inch, which however was quickly dissipated. The aggregate flow from all drill holes penetrating to this seam did not exceed 1 second-foot. The source of this water is unknown but is probably distant. The original high pressure proves the surface layer of rock on which the highest portion of the dam is founded to be remarkably tight.



Plan of Bull Run Dam



Section Through Spillway, Also Showing Other Construction Details

The plans call for a shallow cut-off trench under the heel of the dam in the center of which grout holes are placed. Those reaching across the valley are to penetrate to the seam from which artesian flow arises. These holes are placed 10 feet center to center. Twenty feet down stream from the the line of grout holes there is a row of drain holes likewise at 10 feet center to center and reaching to about equal depth. Both rows continue up the side hills to the top. The drain holes connect with vertical drain holes in the body of the dam terminating in a gallery run-

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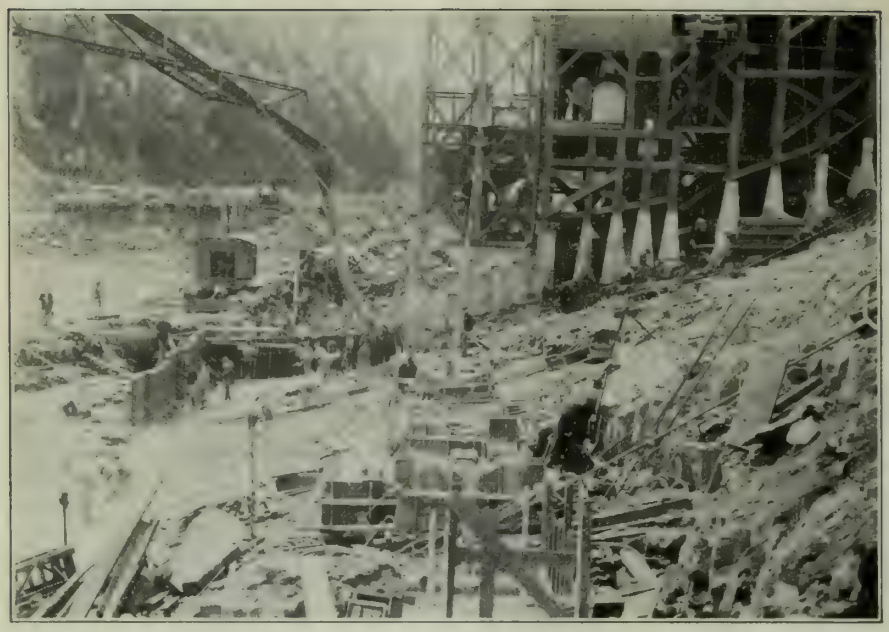


Starting of concrete operations. The above picture was taken August 12, 1927, the day upon which the first concrete was placed.

ning lengthwise through the dam with bottom just above highest water below the dam. A row of drain holes also extends upward from the tunnel to the top of the dam and another row of vertical drain holes occurs further downstream at a distance radially of 56 feet. All drain holes are straight so that they may be kept free from incrustations. Drainage water will discharge through two galleries passing through the dam in a radial direction.

The dam is to be built of concrete with aggregate of sizes ¼ inch, 3 inch and 9 inch carefully proportioned for strength and with well controlled water cement ratio. For proper control a field laboratory has been erected near the mixing plant with necessary testing apparatus. The aggregates are measured by volume. In the lowest part of the dam a mix is used requiring 1 barrel of cement per cubic yard which will be rapidly reduced to ¾ barrels.

The dam will be provided with contraction joints at distance along the outer curve of 40 feet placed on radial planes with offsets forming keys. Near the upstream end a copper stop is placed and 2 vertical drains located in the joint will carry off any water which may pass the stops. All the joints will pass down to the foundation except where interference is had with gate passages in which case the joint will terminate at a higher elevation and steel reinforcement will be placed just below the lower end to counteract the tendency of crack formation extending downward.

Bull Run River is subject to heavy floods especially if compared with the reservoir storage capacity. The maximum flood flow from the 74 square mile area above the dam is estimated at 21,000 second feet. Eighteen hours duration of a flow of this magnitude will completely fill the reservoir.

The flow of Bull Run River in relation to the demand is such that overflow will occur most of the time, which however is estimated not to exceed 3,500 second feet for more than 2 per cent of the time.

Design of Spillways

Spill will take place over the center portion of the dam through three bays 40 feet wide each. The fixed spillway crest is placed 14 feet below the top of the dam, outflow is ultimately to be controlled by drum gates which are designed to raise the water level to 4 feet below the top of the dam. These gates will be omitted for the present thereby cutting storage capacity down from 31,000 to 27,300 acre feet.

The downstream side of the spillway section will merge from a parabola into the ordinary 0.7 to 1 back slope and will be provided at the bottom with a 60 foot radius curve deflecting the water to a horizontal direction over a heavy apron floor on top of bedrock. The water will thence proceed on this floor for a distance of 150 feet and be deflected upward by a cross wall 5 feet high with upstream slopes alternating every 10 feet from 2½ to 1 to 5 to 1. The apron will generally be submerged about 10 feet and the pond thus maintained will normally cause a standing wave near the toe of the dam. It is expected, as a result of experiments with a 1/20 full size model, that a flow of 2,500 second feet will clear the pond after which flow will proceed at high velocity on the spillway floor and be deflected upward by the end wall in two types of parabolas, resulting in a wide spread of erosive attack on the hard rock surface of the river bed within limits of about 40 and 180 feet downstream from the apron end. The area immediately downstream from this end will probably remain entirely free from erosion. A condition of flow 2,500 second feet or greater is estimated to prevail for about 4 per cent of the time, assuming no water to pass through gate passages in the stream.

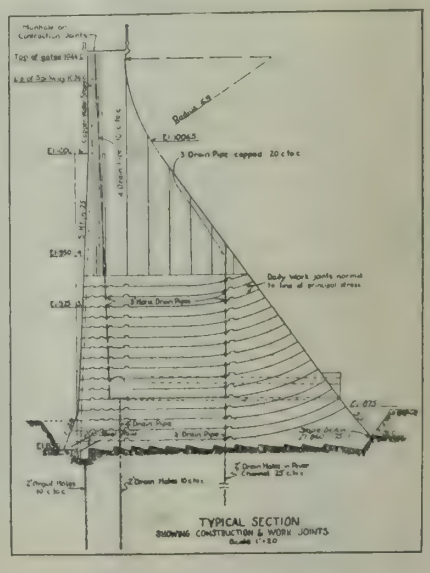
Location of Control Valves

Draft for water supply is controlled through three 3-feet needle valves under maximum head of 155 feet, two of which are figured to be required under low reservoir conditions to discharge the estimated maximum of 500 second feet ultimately needed after complete development of the storage project.

The needle valves are attached to the downstream ends of 4-foot steel pipes passing radially through the dam and being equipped with 44-foot butterfly valves placed vertically above the main gallery through the dam.

The upper ends of the pipe terminate at the face of the dam within a gate tower provided with 7 sluice gates 3x6, 6x8 and 4x6 feet in size permitting water to be drawn from the reservoir at the most favorable depth below the surface.

It was found economical to construct this gate tower in a manner so that the difference in elevation of water in the



Typical Section of Dam

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tower as compared with open reservoir will be definitely limited. The tower is amply strong to withstand a 15 foot water difference. Four horizontal butterfly gates installed near the bottom of the tower will open automatically when the pressure difference reaches 8 feet. A trash rack of very large area intervenes between the sluice gates and the open reservoir.

Vertically below the upstream ends of the outlet pipes there is installed a 3x6 foot sluice gate with sill at present river level with operating mechanism installed on the dam face 60 feet above and accessible only when the reservoir each summer drops below this level. A 66 inch butterfly gate is installed in vertical alignment with the main gallery as emergency gate.

Penstocks for Future Use

For future use by the utility there are provided two 90-inch penstocks with trash racks and upper butterfly valves, closed at the lower ends until needed. Under the penstock intakes there is also placed a 3x6 gate for sluicing purposes with 66 foot butterfly emergency valve downstream.

The dam will have an ornamental finish at the top with concrete arch bridges spanning the central spillway and with electric lamp standards supplied for the present with current from a small power station at the dam which will also provide power for gate operation.

Construction Features

Some special features of design and construction may deserve mention. The concrete is being deposited in 5-foot layers with horizontal keys parallel to the water face, these layers gradually sloping upward in a downstream direction from near the center of the dam so that at the end they approach a direction normal to the back slope. This is done with the object of keeping the surface of the layers as nearly normal as practicable to the direction of principal stresses. The work of concreting commenced early in August, 1927, and no difficulty has been experienced in achieving this result.

The bedrock was thoroughly cleaned. The above picture will give some idea of the type of material encountered, and the method of cleaning.

Inundators are being used to control sand and water proportions. With cement running less than one barrel to the yard it is found that with a water cement ratio close to 1 dehydration is necessary and can be accomplished without delaying the charging of the mixers. Avoidance of delay is partly due to the requirement of 2 minutes mixing after all materials have been dumped in the mixer.

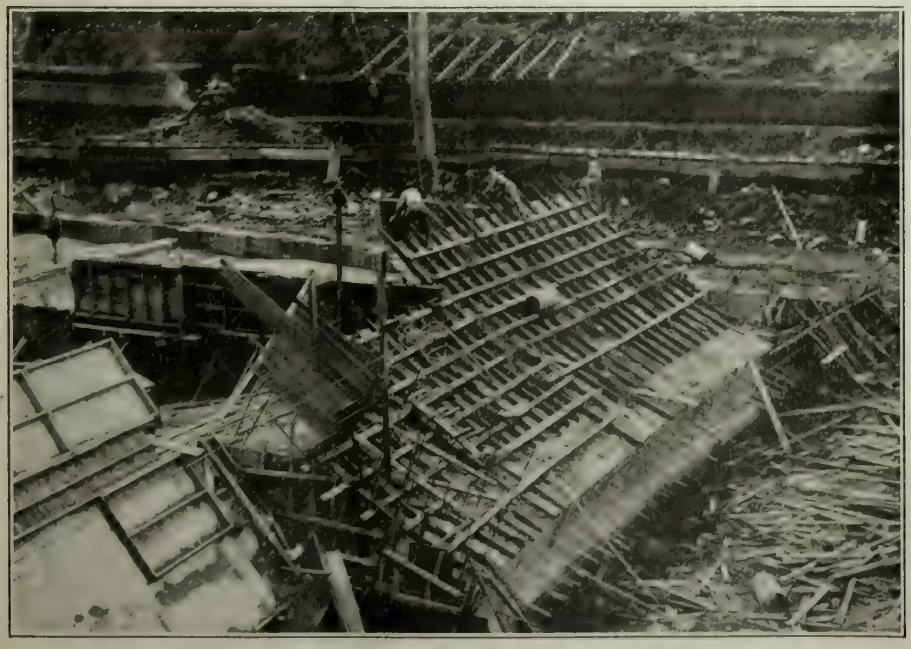
About 75 feet up the left abutment excavation has exposed a contact area between two lava layers of softer material partly clay. Rock has been excavated above to a vertical height of 30 feet and over. It is proposed to run key tunnels in line with the upstream and downstream faces of the dam for some distance into the hill and fill them with concrete, also to clean out the exposed layer between to a maximum practical depth and refill with concrete.

Testing Devices Installed

Resistance thermometers, telemeters and uplift points are being built in the dam to observe temperatures, stresses and uplift. Gage points are being placed across contraction joints to measure movement, all under the supervision of a special Committee of the Arch Dam Committee of Engineering Foundation.

Contamination of the river by the construction camp is prevented by a complete sewer system with concrete septic tank, chlorinator and duplicate electrically driven pumps lifting the sewage over an 1,100 foot high intervening divide into a creek outside the water

(Continued on Page 85)



Progress picture, taken August 29, 1927.

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A vague conception of the magnitude of the Columbia River Basin Project may be obtained from the above view, which was taken from the top of Saddle Mountain, looking northeast. This shows the depth of the land that will be affected.

World's Largest Irrigation Project Now Being Planned by Four States of Northwest

Contemplated Development of the Columbia Basin Irrigation Project Allows the Reclamation of 1,883,000 Acres of Virgin Territory

By R. K. TIFFANY
Washington State Supervisor of Hydraulics

THE Columbia Basin Irrigation Project contemplates the irrigation of a maximum area of 1,883,000 acres. This is some 800,000 acres more than the area for which water was available for irrigation in 1926 of all the Federal Reclamation projects in fourteen states. At first glance, it might appear rather an ambitious undertaking for the State of Washington to attempt development of a project of this magnitude; but when comparisons are made of present irrigated areas with the population, manufacturing and commerce of the principal irrigated states, the project appears in quite a different light.

Of the twelve principal irrigated states, Washington ranks eleventh in the area for which water is available with only 637,000 acres, the only state with smaller area being Arizona. Her rank in population in the same group of states is third, with only California and Texas leading; and her rank in manufacturing is second as to number of employees and third as to value of production.

Of this group Washington has ten per cent of the total population, eighteen per cent of the total number of wage earners, thirteen per cent of the given value of manufacturing products, *but only two and a half per cent of the irrigated area.* (See table).

TABLE SHOWING IRRIGABLE AREAS, POPULATION, NUMBER OF WAGE EARNERS AND VALUE OF MANUFACTURING PRODUCTS IN TWELVE WESTERN STATES.

	Irrigable Area Under Existing Projects	Population	Manufacturing Wage Earners Employed	Manufacturing Value of Products
California	5,894,466	4,316,000	246,154	2,215,281,000
Colorado	3,855,348	1,059,000	31,226	255,190,000
Idaho	3,092,810	522,000	16,347	87,429,000
Montana	2,753,498	695,000	15,943	174,874,000
Nevada	704,708	77,000	4,666	22,243,000
New Mexico	696,119	388,000	5,459	20,422,000
Oregon	1,344,046	877,000	62,655	363,715,000
Texas	1,150,542	5,313,000	102,358	979,192,000
Utah	1,700,550	514,000	15,901	191,590,000
Washington	637,151	1,538,000	111,663	678,543,000
Wyoming	1,831,039	236,000	7,510	110,632,000
Arizona	627,303	445,000	9,008	123,377,000
Total	24,287,580	15,980,000	628,890	5,222,488,000

"Western Waterworks" Begins on Page 33

fore, the Columbia Basin Project were fully developed, Washington's irrigated area would not be out of proportion when compared to her population, wealth and consuming capacity.

It is for this reason that substantial business men throughout the State have felt justified in promoting the project, urging that it be thoroughly and carefully investigated, that fundamental conditions relating to water supply be adjusted, through agreement with other states, and that plans be laid, looking toward actual construction of the project when economic conditions warrant.

With this in view, the Columbia Basin Irrigation League, having a large membership, not only in the State of Washington, but including many substantial representatives from the adjoining states of Oregon, Idaho and Montana, has during several years past secured appropriations of state and federal funds to cover the cost of elaborate preliminary investigations. This organization also secured the passage of bills by the several state legislatures and by Congress, authorizing the negotiation of a compact for equitable distribution of the waters of the Columbia River among the four states interested.

The project contemplates the irrigation of a maximum area of 1,883,000 acres, all of which can be served by a gravity canal from Clarks Fork of the Columbia River with auxiliary pumping. Parts of the area may be served from other sources, these other possible sources being the Wenatchee River, which could be made to serve from two hundred to three hundred thousand acres in the Quincy district; Priest Rapids Pumping Project, which would serve approximately one hundred thousand acres by direct pumping lift, in connection with the Priest River Power Project; the Five Mile Rapids Pumping Project, which could serve sixty or seventy thousand acres, pumping with power developed in the Snake River near its confluence with the Columbia; and the Eureka Flats Project, of which some sixty thousand acres could be watered by gravity flow from the Touchet and Palouse Rivers.

The main area, or the larger portion of it, can also be served by means of a gigantic pumping system. This would involve the building of a dam two hundred feet high in the Columbia River, which would develop power sufficient to lift water from a reservoir above the dam to an elevation some four hundred feet higher. From this elevation it would be distributed by gravity canal to about 1,400,000 acres and lifted by secondary pumps to other lands. Some little controversy has developed between partisans of the two main plans, but official state and federal reports have recommended the gravity plan. Final selection may depend largely upon the prospective market for surplus power and upon whether or not suitable arrangement may be made by interstate compact for storage supplies essential to the gravity project. For construction under the pumping plan, no storage is required in other states.

The project is located in South Central Washington, being partly surrounded by Big Bend of the Columbia River. The central part of the project is distant approximately 250 miles from Portland or Puget Sound and slightly over 100 miles from Spokane.

The soils vary from fine sand and sandy loam underlain by coarse sands and gravels toward the Columbia River to heavy silt loam at the eastern or upper edge of the project. There are scattered areas of rocky and gravelly lands but these have been classified as non-irrigable. All the soil of the land considered irrigable is similar in type and texture to soils already successfully irrigated in other parts of the state.

The altitude ranges from about five hundred feet, near the Columbia River, to approximately seventeen hundred feet in the eastern part of the project. The land slopes gently to the south and west, parts of it having been under cultivation for many years.

In the easternmost parts, crops of wheat are raised by dry farming methods. In the western part the rainfall during the past ten years has been too little for profitable farming. The rainfall varies from approximately two inches at the western boundary to fifteen inches or more in the eastern portion. Most of this falls outside the growing season. The climate, generally speaking, is mild with long rainless summers, favorable to the maturing and harvesting of crops.

The crops grown would be, generally speaking, similar to those grown in the

(Continued on Page 80)

A view of Albany Falls, near point where the water will be diverted into the main canal feeding the Columbia River Basin Project.

"Western Waterworks" Begins on Page 33 ☛

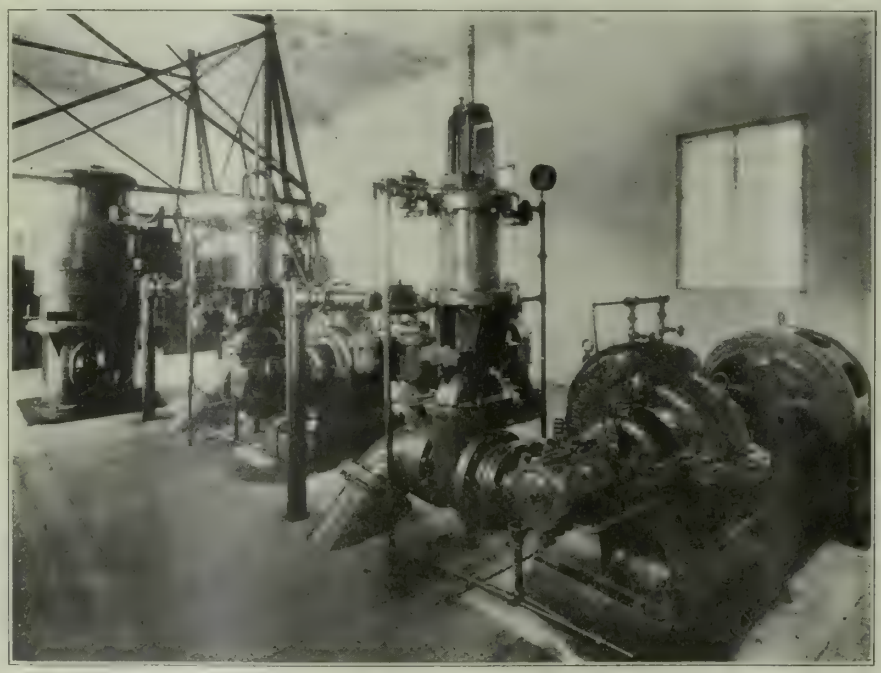
Economic Development of Sub-Surface Water Supplies by Deep Well Turbines

Small Communities along Pacific Coast Find Turbine Installations Solve Waterworks Problem to Advantage

By ROBERT SCHURMAN

THE development of the modern deepwell turbine type of pumping equipment has made possible a new and highly satisfactory solution for the water supply problem in small municipalities. In times past, the small towns, and even large cities, have depended for their water supply on streams, fresh water lakes or springs of doubtful purity.

Numerous large cities have seen fit to run aqueducts immense distances to bring in fresh and unpolluted water. The first cost of constructing such aqueducts, and the lack of sufficient sources, makes this solution of the water supply problem for small cities impractical, if not impossible. Nature, assisted by deepwell turbines, however, does offer an inexpensive supply of pure water which may be tapped at a first cost approximately in proportion to the flow obtained.



The above shows an automatic waterworks. The deep well turbine delivers the water from the ground where it is picked up by the booster pump and delivered into the high pressure system. The operation of this entire system is automatic, the pressures being maintained by the various pumps which are controlled by electrical devices.

We all recall from our high school natural history or geology that in times past the surface of the earth has been built up of successive layers of sand, clay, gravel, rubble, rock and various alluvial and igneous and metamorphic deposits. In almost any locality there are porous strata beneath the surface which form more or less continuous channels back to the mountains or faults where it is possible for water to seep into them. These strata usually lie under clay beds which are impervious to the seepage of surface water which might carry pollution.

The beds of sand and gravel also operate as a gigantic filter to catch organic material carried underground at the source of supply. The prediction is here made that in the course of the next twenty-five years vast projects will be developed to divert flood waters in the mountains into wells drilled into the subsurface sand and gravel strata or perhaps, in some instances, the water may be diverted to areas where the sand and gravel strata come to the surface. Such projects will replenish or build up subterranean water reservoirs, diminish wasteful erosion, and prevent destructive floods.

This is the next step for certain districts which have been draining subsurface reservoirs for many years past. The water bearing gravel strata may be regarded as vast underground lakes, having about 70 per cent of their volume filled with gravel and their remaining 30 per cent with water. If water is pumped from such a lake faster than it seeps in, the "water table" will naturally lower as the pumping continues, and steps must be taken to replenish the supply.

Modern Well Drilling

When certain pioneer municipalities turned to deepwell turbine pumps for their water supply they were not experimenting, but were rather adapting equipment which had proven itself practical and feasible in irrigation service over a long period of years.

Typical Plant

A typical municipal installation consists; first, of a well drilled down to water bearing gravel strata cased all the way down; of having the casing perforations in the water strata, and the undesirable flow from higher strata sealed off by proper cementing. While pumps can be installed in casings as small as 6-inch, it is desirable to drill much larger wells, either 12, 14 or 16-inch. If the well is much larger than the pump column, minor settlings may occur without danger of cramping the deepwell pump. Likewise, the entering velocity is smaller around the larger circumference, and it is, therefore, less likely that solid material will be carried into the well or that the perforations will be stopped.

The next part of the municipal installation is the deepwell turbine, which may be of sufficient size to deliver the water into a surface settling tank when

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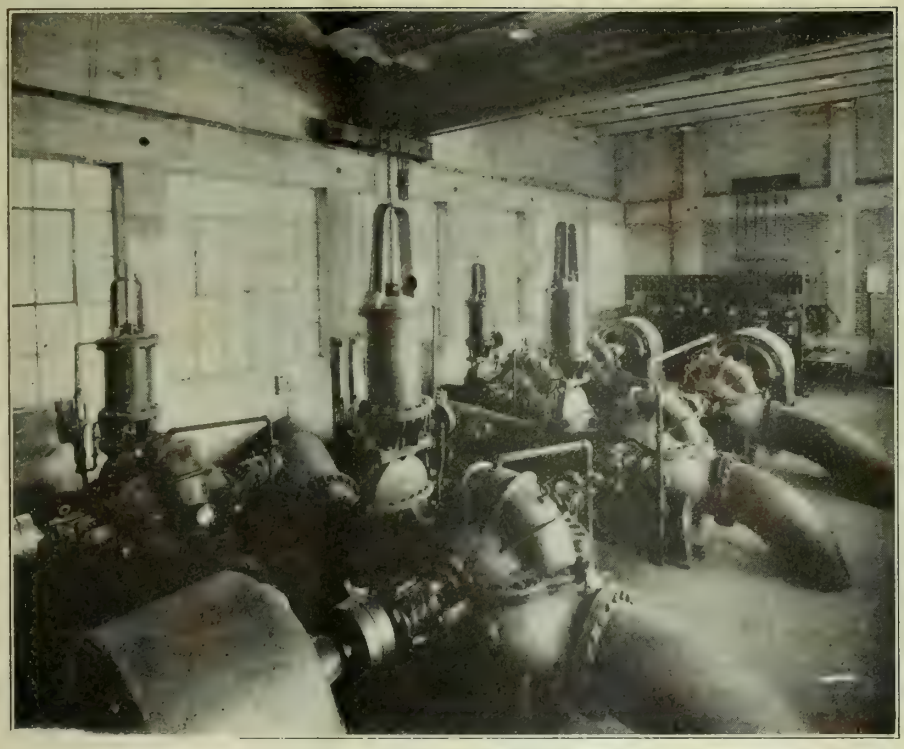


The above photo shows a medium sized booster plant. A number of small units are placed in parallel, which enables the operator to obtain a maximum efficiency over a wide range of operating conditions.

there is an appreciable amount of sand in the water, or the deepwell turbine may be used to boost the water directly into an elevated tank or reservoir. When it is used to discharge into a surface sump or settling basin, it will be necessary to employ a booster pump to lift the water into the elevated tank or to force it into a hydro-pneumatic pressure tank for small installations. With proper electrical apparatus installed, such an installation can be made completely automatic.

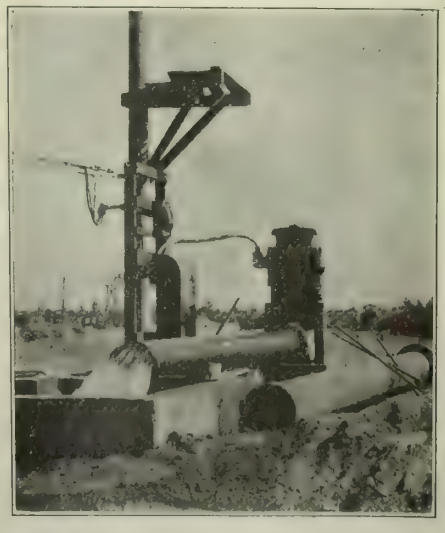
Automatic Features

Pressure governors or switches may be set so that pumps will be automatically started when the water has been lowered to a certain predetermined level and will also stop the pump when the water level or pressure has again reached its selected maximum point. This feature makes a great many small municipal water works one-man propositions, the same mechanic being able to operate the pumps and care for all other incidental service.

The exact design of the system from the deepwell turbine on is influenced by the special local conditions to such an extent that it is difficult to generalize. The turbine may be set with a float switch to maintain a large sump at predetermined level while a small high pressure pump, having a capacity approximately equal to the average demand, is installed to pump from the sump into the elevated tank or hydro-pneumatic tank. It is desirable to select size of tanks and pumps so that it will not be necessary for the pump to be started and stopped more than three, or possibly four, times an hour.

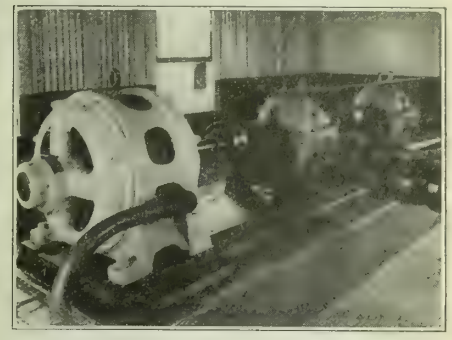
Use of Reservoirs

When a hill is conveniently located it is a common thing to place a large reservoir on the hill, which reservoir is kept full by the deepwell turbine directly, or by a deepwell turbine in conjunction with a booster pump, or by a number of small deepwell turbines supplying one large booster pump. When making such installations, however, there should be no attempt to save a few thousand feet of pipe line by drilling the wells up on a mountain side.



A typical deep well turbine installation. The pump shown above is delivering 7650 gallons per minute from a well 24 inches in diameter and 209 feet in depth.

You will remember Johnnie's directions for killing fleas. It started off, "First catch the flea"; so it is with deep-well municipal water systems. First get your water, and then pump it where it should go afterward. It sounds perfectly silly, but it is amazing how many times people design the reservoir and pumping system, and then try to drill wells conveniently located to them and attempt to obtain water. Again we repeat, get the water first.



After the water is lifted from the well a series of booster pumps may be used to deliver the water to any desired locality.

It would require a thick volume to set forth the thousand and one little practical details which go to make up a successful installation. The various pump manufacturers, however, maintain field engineers who are capable of offering valuable advice regarding such installations.

Foothill District Votes Bonds

The Foothill Irrigation District, Tulare County, California, on August 1 voted a $2,300,000 bond issue with 604 votes for and only 14 against the proposition. The district includes 50,000 acres just inside the valley floor. Under the issue the Foothill irrigation district in exchange for water on the Kings River, heretofore owned by the Murphy Slough irrigation district, will purchase approximately 10,000 acres of land in the latter district and sink 25 wells at an outlay of $600,000 for the land and wells, according to announcement of Max Enderlein, Foothill district engineer. The lands upon which the wells will be sunk lie 18 miles south of Fresno in the Conejo section. Through this agreement for the water exchange between the two irrigation units, the Foothill system will build a diversion canal from the river at Avocado and will carry gravity water to its lands.

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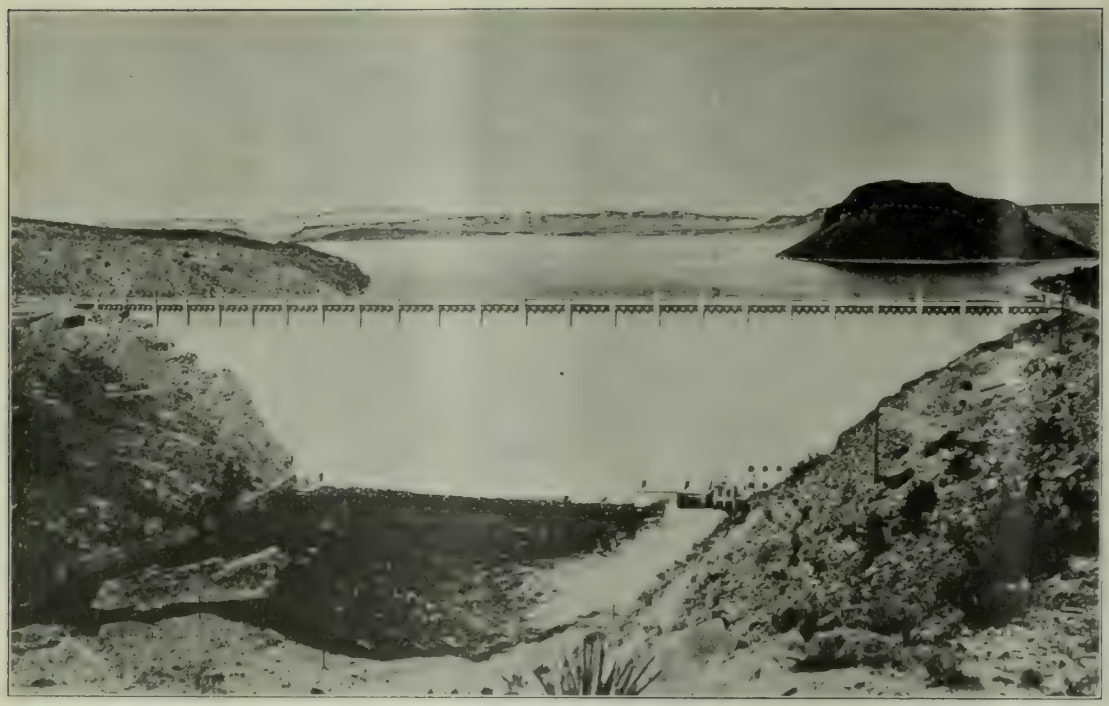

The Elephant Butte Dam and storage reservoir, Texas-New Mexico, is probably the largest artificial lake in the entire world. It has a capacity of 2,642,292 acre feet.

Transmission and Delivery of Water to Remote Irrigation Districts

Impounding of Great Volumes of Water at Convenient Locations Necessitates Long Distance Transmission

By G. CLYDE BALDWIN*
Member American Society Civil Engineers

THROUGHOUT the early stages of irrigation development in our western states, reservoirs were of little consequence. Land was watered by direct diversion from the natural streams with small effort and at no great expense. The success of the pioneers naturally attracted others, more difficult enterprises were undertaken and, following the enactment of the Federal Reclamation and Carey Acts, really large undertakings were initiated. By this time, also, the low water flow of many of the streams had proved to be insufficient to supply all demands. For this reason, and because of the feasibility, under these laws, of financing the construction of dams and other necessary works of considerable magnitude, storage reservoirs began to play a part of constantly increasing importance in all reclamation plans until today they are usually considered to be the foundations upon which most new irrigation projects must be based.

Low unit storage cost together with the physical possibility of making gravity deliveries chiefly governed the location of these early reservoirs, and scant consideration was given to the other difficulties which might later be experienced in connection with their operation.

Where the selected impounding basin is located close to the irrigable lands, on otherwise dry channels, or on small streams where no conflict with other water rights exists, these operation or delivery problems are comparatively unimportant. They become very real and worthy of consideration, however, in cases where the storage must be transmitted for long distances down the natural channel of a large stream, most of the normal flow of which has been awarded to other and earlier appropriators.

Situations of the latter character are now to be found in most of the western states but probably none is more complicated or involves the administration of such large quantities of water as that of the upper Snake River basin in Idaho and Wyoming.

In that portion of this area which, for water distribution purposes, is administered as a single unit, four major and several minor storage reservoirs are now in operation. Without taking into consideration small diversions upon the upper reaches of the streams which are relatively isolated and where net consumption of water is usually small, water is diverted from the river and its larger tributaries through about one hundred and twenty principal canals.

Four Large Reservoirs

The four large reservoirs are Jackson Lake situated at the upper end of Jackson Hole, Wyoming and only a few miles south of Yellowstone National Park, with a capacity of 847,000 acre-feet; Henry Lake, located near the head water of the North or Henry's Fork of Snake River, whose capacity is about 75,000 acre-feet; American Falls, on the river just above the town of American Falls, Idaho, where the full capacity of 1,700,000 acre-feet is available for use in this the first year since the completion of the dam; and Lake Walcott which was created by the Minidoka diversion and power dam of the U. S. Bureau of Reclamation and where about 107,000 acre-feet are normally impounded and can be used, at the sacrifice of power head, in times of urgent need.

The canals range in size from those with a capacity of only one or two second-feet up to one of more than three thousand six hundred second-feet. The maximum for the entire group amounts to nearly 30,000 second-feet while the total diversions from May 1 to September 30 in a normal water supply year equal almost 6,000,000 acre-feet.

Henry's Lake Reservoir is owned and utilized entirely by canals located in the vicinity of St. Anthony, Idaho, while Lake Walcott belong to the adjacent Minidoka Project. Roughly 15 per cent

*Extracts from a paper presented before the Denver meeting of the Am. Soc. Civ. Engs., held July 14, 1927.

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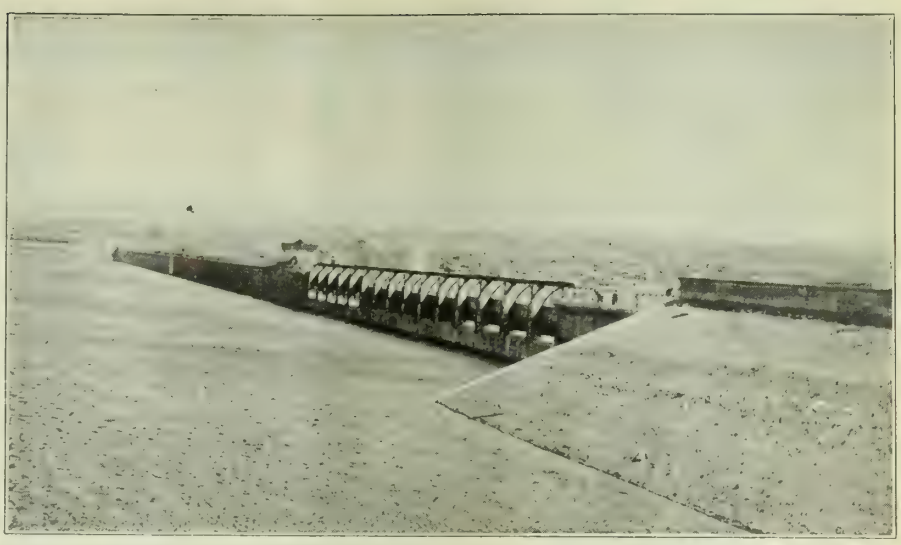
of the combined storage impounded in Jackson Lake and American Falls Reservoirs belongs to canals in the so-called Idaho Falls section, 14 per cent to the Minidoka Project, 38 per cent reserved for as yet undeveloped enterprises, 2 per cent to the Idaho Power Company and the balance or 31 per cent to the Twin Falls-Jerome canals which divert at Milner Dam, the extreme lower end of State Water District No. 36.

The natural stream channels must be used for carrying all stored water, except that impounded in Lake Walcott, from the reservoirs to the points of final diversion and use. In the case of Jackson Lake water this now means transmission of more than half of the total for a distance of about three hundred miles, past the headgates of the Idaho Falls region canals and on through the American Falls and Lake Walcott Reservoirs.

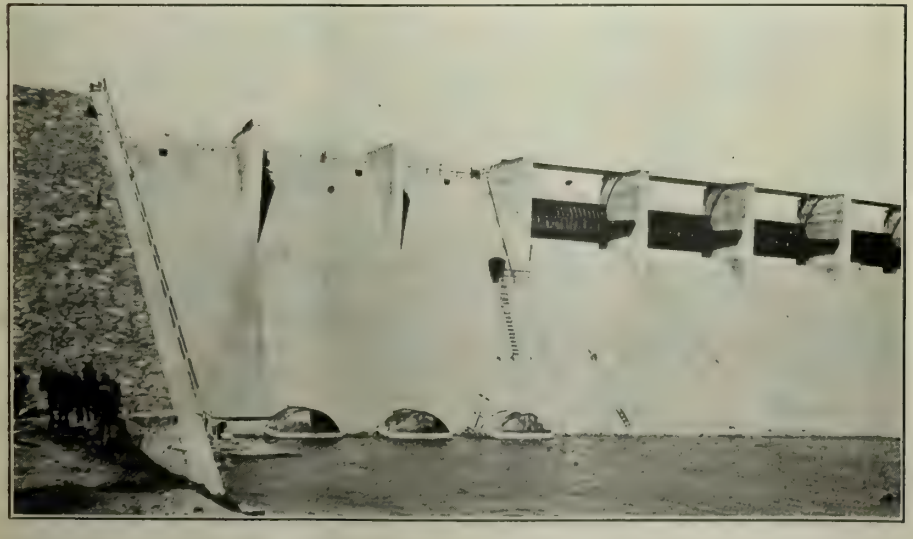


The American Falls Reservoir, Idaho, is the second largest reservoir, having a capacity of 1,700,000 acre feet. The above view is looking east toward the town of American Falls, which was moved to make way for the reservoir.

Use of Stream Beds as Channels

Normal flow water rights have been decreed at the canal headgates but stored water, on the other hand, is acquired at the reservoir. Both Wyoming and Idaho provide by statute for the use of stream beds as channels for the conveyance of storage but there is no prescribed basis for converting a reservoir right into a right at the point of diversion many miles downstream. Everyone agrees that some deductions should be made for transmission loss but there is a wide divergence in views as to how this loss shall be determined. The latter range from a minimum proportional charge based upon estimated additional evaporation and seepage resulting respectively, from the extra exposed surface and wetted perimeter caused by the storage run, up to a direct proportional quantity tax through each small section of river channel where net losses are known to occur, with no corresponding credits in sections where the river shows a net gain.

During the first few years after the completion of the original temporary dam at the outlet of Jackson Lake attempts were made to deliver the storage to the lower valley in a series of flush heads. Prior to the arrival of each of these flushes, canals in the Idaho Falls area were staked and river riders were employed to make certain that this normal draft was not exceeded during the storage run. Under this delivery plan Lake Walcott was operated as a catch basin and equalizing reservoir. This method resulted in net storage losses amounting to between 25 and 30 per cent, while the alternate high and low river stages were very destructive to the less permanent diversion dams along the stream and made difficult the maintenance of any uniform flow in the canals. It was consequently unsatisfactory alike to stored water and normal flow users and beginning in 1912 was abandoned in favor of a continuous flow system which, with certain modifications pertaining chiefly to transmission losses, has been in use since that time.



The American Falls Dam is 5,227 feet in length, and is a combination concrete and rock fill structure. The above view was taken at the west end of the dam where the Government power plant eventually will be installed.

Continuous Flow System Used

Under the latter system the rate at which storage is released from the reservoir varies with the needs of the stored water users but abrupt fluctuations of any large amount are avoided. Allowance is made for time of transmission and loss in transit, then the intervening canals having normal flow rights are so regulated in accordance with the decrees as to insure proper deliveries each day. The daily determination and frequent regulation of flow in each canal as well as the maintenance of continuous records at numerous river points is required.

For many years, and to a considerable extent even yet, the amount to be charged against this storage as transmission loss continued to be subject to dispute and provocative of much dissension between stored and normal flow, or on geographical lines, lower and upper valley water users.

Numerous partial investigations of different phases of this problem were authorized from time to time; most of which, because of the experienced and disinterested personnel obtainable, were conducted by or under the supervision of the Water Resources Branch of the U. S. Geological Survey. These served gradually to accumulate certain facts concerning river losses and gains and the

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The EDITORIAL

MODERN Irrigation

Reg. U. S. Pat. Off.

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Our Water Supplies

BECAUSE of the fact that water is an every day necessity, few persons appreciate its importance until the limits of the supply are approached. When reminded of it, every one recognizes, of course, that water is necessary for both plant and animal life and that it must be furnished frequently to the cultivated field by the natural phenomenon of rainfall or by the artificial process of irrigation, and constantly to the home by means of the nearby well that reaches into the ground water, or by the aqueduct, either great or small, that brings water through a pipe or system of pipes from a distant source of supply.

There are many people who do not realize that water is also required in large quantities for the generation of mechanical and electrical energy, whether by water power or by steam power plants, that it is necessary for many industrial processes, and that it controls and limits in many regions the nature and extent of development and growth along lines of human activities.

Unfortunately the supply of water in any locality is limited by nature and cannot be appreciably increased by any device of man except in those rather rare localities where diversion from one drainage basin to another is practicable. The distribution of the supply of water throughout the year can, of course, be modified by means of storage reservoirs, but the total supply in a region is not only never increased thereby but instead is actually decreased by the evaporation from the exposed water surfaces created by such reservoirs.

As soon as the total supply is utilized, therefore, development must stop, and new uses can be made of the water only as the old uses are abandoned. In recent years the demand for water has become so great for so many purposes that there is an actual shortage in many regions.

As the country grows in population and industries, the deficiencies in water supply are becoming increasingly apparent. Such deficiencies were naturally first felt in arid and semi-arid regions, where the excess of good arable land over the supply of water for its irrigation disclosed clearly the limiting effect of water on development.

More recently similar deficiencies of water for use in industrial regions have emphasized the limiting effects of water on the growth of cities, on the development of both steam and water power, and on the construction of industrial plants that require large quantities of water of definite chemical quality for use in industrial processes.

The present shortage of water in all sections of the country and for many uses is demonstrated by the great expenditures already made in providing satisfactory systems of water supply for large cities, by enormous investments in irrigation works, and by the extensive studies that are being constantly made for augmenting existing supplies of water by means of storage reservoirs, and for obtaining new supplies from both underground and surface waters from nearby or distant sources to be utilized by cities, irrigation districts, and industries.

Waterworks and Water Pipe

THE past few years have seen many new developments in the waterworks field, and the twelve months just passed are no exception. Science is constantly gleaning additional information regarding the harnessing of the forces of nature. This year has seen many advancements in the manufactured pipe industry, these developments and improvements not being confined to any particular kind or type of pipe, but to the industry as a whole.

Among the most notable of these is in connection with concrete pipe manufacture. There has been developed a product of concrete which, to put it mildly, is unusual. To perfect such a product of rock material, which has a density equivalent to marble, which is impervious to moisture, and so carefully reinforced that it is able to withstand the heavy internal pressures demanded for many classes of water supply lines, has been the aim of the concrete pipe industry for years past. This new product has now taken a position where it

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POINT *Of* VIEW

is in direct competition with steel and cast iron pipe, but these two latter products have also been subject to individual improvements materially increasing usefulness and efficiency.

In regard to steel pipe, we find that the introduction of the oxy-acetylene and electric welding methods, as they are now applied, has greatly changed practises in vogue a few years past. Larger sizes of pipe are now being utilized, the electric welded seams taking the place of the butt-strap riveted joints. There have also been developed several styles of patented joints which utilize the electric welding process in the pipe fabrication. This method of electrically welding the lateral seams has been widely adopted, especially here along the Pacific Coast, as engineers claim that such type of fabrication offers less resistance to the transmitted water than does the riveted type of construction.

Welding of the circumferential seams with oxy-acetylene torches, while somewhat new to the waterworks industry, is standard practise in the oil and gas industries such methods having been successfully used for several years. Electric welding and oxy-acetylene welding are no longer in their infancy, but are an established process recognized by virtually all leading authorities.

While steel and concrete pipe improvements have been occupying the center of the stage during the past twelve months, new developments in cast iron pipe have been by no means lagging. Cast iron pipe has for many years predominated in waterworks practise, because of its natural ability to resist corrosion. This alone is a most important factor. The chief objection to cast iron pipe has been its weight, because virtually all such pipe used on the Pacific Coast is imported from eastern states, and the freight charges are rather high. This has been the main reason for the western waterworks industry to look to other classes of pipe which make a less expensive installation. However, cast iron pipe manufacturers have now developed a centrifugal cast product, which is considerably lighter in weight, yet retains all the strength and corrosion resisting features of the old type of pipe. The centrifugal process allows the manufacture of a pipe of greater density, which means greater strength and greater corrosion resistance.

Concurrent with these many developments in pipe fabrication, there have also been many advancements made in the use of exterior coatings for the prevention of corrosion. Intensive studies have been undertaken on this subject with the result that there have been devised many new corrosion resisting materials, and many new methods of pipe protection. Many of these protection methods consist of paints and preservatives applied to the exterior of the pipe, together with the treatment of the water carried within. Other methods consist of wrappings and cement coatings, the latter sometimes being also applied to the interior of the pipe.

In view of the developments in pipe materials alone, it must be realized that all equipment used in the entire waterworks industry is gradually being improved, which places the industry on a more efficient basis.

Impure Water

IN order to eliminate as much as possible the many sources of disease, there must be a general co-operation of all intelligent people, for the right to enjoy health is quite as sacred as the right to possess property. As a general proposition, our sanitary laws governing our water supplies are very good, but their administration leaves much to be desired.

To ignorance and carelessness must be attributed much of the causation of disease in the centuries gone by. Out of the throes of suffering and death of the myriads who have preceded us we have obtained a certain enlightenment which, while not perfect, makes it absurd to plead ignorance and lack of knowledge.

The day is not far distant when it will be considered a crime for a city to furnish its inhabitants with an impure water supply. Diseases, such as typhoid fever, traceable only too often to a town's water supply, which consign thousands to the grave, leave even worse results by passing on to the children a hopeless poverty, which is the gateway to crimes of major proportions. All the medical authorities agree that contagious diseases react upon the moral fibre of a community or people, and contrariwise, where they live under healthy conditions great advancement in government, literature and science has been made.

There is no moral obligation to be intelligent. Ignorance is a vice and when it results in injury to any one it becomes a crime, moral, if not statutory.

It is generally assumed that the larger portion of deaths resulting from typhoid fever are either directly or indirectly attributable to impure water. It is also generally assumed that for each case of typhoid caused by impure water there are at least ten other cases of disease other than typhoid resulting from the same cause.

There is scarcely any one thing more unquestionably established than the practibility of furnishing pure, safe, satisfactory water, irrespective of the condition or degree of pollution of the available natural supplies. An authority on this subject has emphasized this by saying: "When anyone dies of typhoid fever, it is a crime, and some one should be punished; by hanging, if necessary." This may appear to be a rather harsh statement, but it is a thoroughly well established fact that typhoid is an almost wholly unnecessary and preventable disease.

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San Jose Water Supply Derived Mainly From Subterrnean Wells in Valley Floor

Modern System of Storage Reservoirs, Pumping Plants, and Pipe Lines, Provides For City's 80,000 Inhabitants

By H. S. KITTREDGE
Secretary San Jose Waterworks

THE water used by the San Jose Water Company is derived from two general sources of supply—surface waters gathered in the Santa Cruz mountains, which form the barrier between Santa Clara Valley and the ocean, and subterranean waters drawn from the deep gravel measures underlying the Santa Clara Valley.

The mountain supply is obtained from the catchment area of Los Gatos Creek, the largest stream on the east slope of the Santa Cruz mountains. Water is diverted at several points in the watershed of Los Gatos Creek. Reservoirs are used for storing flood waters with which to augment the summer flow of the stream. The Williams, Howells and Lake Ranch Reservoirs are the principal ones used for this purpose, the stored water being drawn from the reservoirs as needed and conducted down the creek channel through lands owned by the San Jose Water Company. The ownership of these lands insures the continued purity of the water, and is the only means whereby the supply may be effectively guarded against contamination.

Deep Well Supply

In addition to the surface supply, the San Jose Water Company draws water from deep wells in and near the City of San Jose. These wells vary in depth up to 1,530 feet and are bored with diameters from 8-inch to 20-inch. They tap the deep gravel measures underlying the Santa Clara Valley. Owing to the great depth of the source the supply is absolutely pure in quality and uniform in quantity.

These gravels occur in lenticular form and are the remnants of ancient streams which crossed and recrossed the valley floor, swinging pendulum-like from one side of the valley to the other as the beds of the old streams were built up by the deposition of gravel, sand, and clay carried down during floods from the surrounding mountains. The alluvium deposited in this manner and now forming the valley floor probably has a depth of over 2,000 feet, forming a vast underground reservoir which is tapped by the deep wells of the San Jose Water Company.

The Tisdale Pump Station is operated by electric power, and has a capacity of 1,400 gallons per minute. This station pumps from Tisdale Reservoir into the Los Gatos system, and may also be used to pump into the Mountain Springs reservoir, using the Los Gatos distributing system as a conduit for this purpose.

The Buena Vista Pump Station is equipped with electrically operated pumps, and has a capacity of 3,600,000 gallons per day. Water is drawn from deep wells by means of small multiple-stage turbine pumps placed in the well casings, discharging into a tank from which it is pumped directly into the San Jose distributing system.

The Main Pump Station, located at Santa Clara avenue and River street is an electric plant, having a total capacity of 5,760,000 gallons in twenty-four hours.

The Seventeenth street Pump Station is electrically operated, and has a capacity of 4,610,000 gallons per day. It pumps from deep artesian wells directly into the San Jose distributing system. Water is supplied to the pumps by small units in the wells as at Buena Vista.

The Bascomb avenue station is electrically operated, its capacity being 3,600,000 gallons per day, pumping from deep wells into a storage tank.

The Cottage Grove station is also electrically operated, and has a capacity of 3,300,000 gallons per day, pumping from deep wells into a 42,000-gallon storage tank.

New Transmission Line

As a part of our operations for the upbuilding of the city and county, we are this year installing a new transmission line and distributing system to serve the East side. This is being done under an agreement with the East Side County Water District, whereby we provide them with water from the San Jose Water Works distributing system. The supply originates primarily in our Ribera pumping plant. The transmission line includes 20,000 feet of 16-in diameter 3-16-inch plate welded steel pipe with soil-proof covering, fabricated and installed by Western Pipe and Steel Company of California. This line is laid on Santa Clara street and Alum Rock avenue from Seventeenth street to a reservoir to be constructed on Fleming avenue, south of Alum Rock avenue.

The reservoir on Fleming avenue will be built on a tract of land containing 2.63 acres at an approximate elevation of 210 feet, U. S. G. S. Base, and will have a capacity of 2 1-2 million gallons more or less. It will be constructed by excavation and fill, using excavated material to form compacted banks lined with concrete or other waterproof material, and covered with a wooden roof.

The Fleming Plant

A motor driven pump in duplicate with a capacity of 300 gallons per minute each against a head of 280 feet more or less will be installed on the Fleming avenue property, and pump water to a second reservoir to be located on 2.073 acres of land on Miguelito avenue south of Alum Rock avenue. These pumps will pump water through 6,000 feet more or less of 12-inch, No. 10 gauge welded pipe, also supplied by Western Pipe and Steel Company.

The Miguelito Avenue Reservoir will be at an approximate leevation of 470 feet, U. S. G. S. Base; will have a capacity of 1.8 million gallons and will be constructed in the same manner as the Fleming Avenue Reservoir. Two duplicate motor driven pumps with a capacity of 300 gallons per minute each against a head of 300 feet more or less will be located on the Miguelito Reservoir lot, and pump water through 2,200 feet more or less of 10-inch, No. 10 gauge welded pipe laid in Alum Rock avenue and through lands of M. C. Brundage, et al., to a steel tank with a capacity of 300,000 gallons on 1.465 acres of land at an approximate elevation of 720 feet adjoining Buena Vista Park.

This 10-inch welded pipe and the steel storage tank are also being supplied by Western Pipe and Steel Com-

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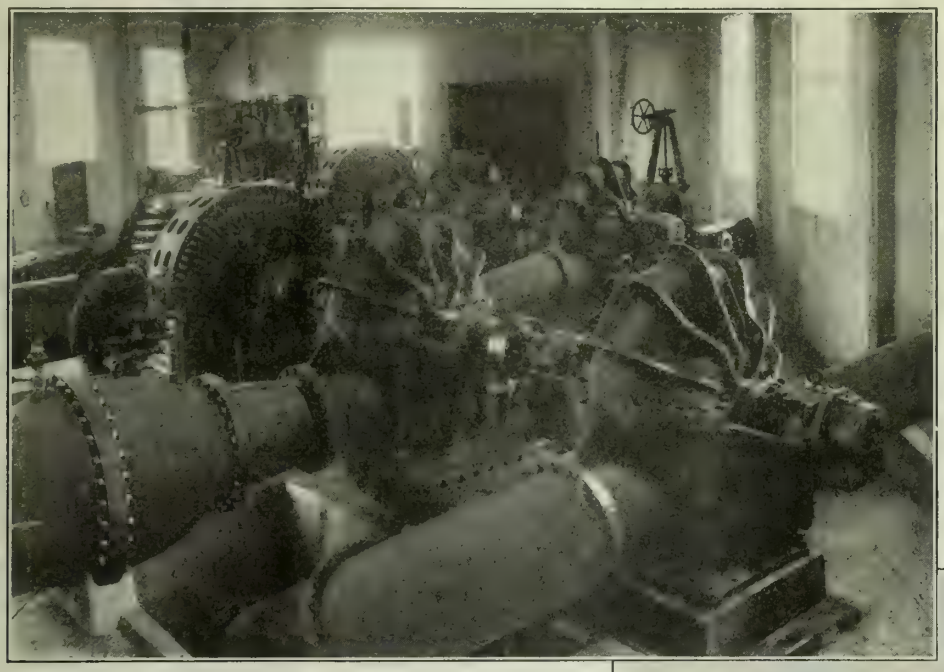
PELTON

High Efficiency at Walnut Creek Plant



Interior of Walnut Creek pumping station showing two of the three Pelton pumps installed.

Exterior of Walnut Creek plant.

THE Walnut Creek pumping station of the East Bay Municipal Utility District is one of the most modern and efficient plants of its kind yet built for water works service. Its purpose in the Mokelumne water supply project is to increase the normal gravity flow of the system from 25,000,000 G.P.D. to approximately 75,000,000 G.P.D. in serving eight cities on the eastern shore of San Francisco Bay. More than 5000 Hp. in electric motor capacity is installed.

Three complete pumping units were built in our San Francisco works for this installation, each consisting of two standard Pelton Type DS pumps mounted in series and direct driven by 1600 Hp. motors. The units operate against a head of 285 ft. with a rated output of 25,000,000 G.P.D. and under these conditions showed efficiencies in excess of 85% during the official acceptance tests made by the District engineers. Johnson type check valves, gate valves and other accessory equipment were also furnished for this station.

THE PELTON WATER WHEEL COMPANY

HYDRAULIC ENGINEERS

2927 Nineteenth Street, SAN FRANCISCO 100 Broadway, NEW YORK

Divisional Office in American Trust Building, Birmingham, Ala.

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PELTON

"Western Waterworks" Begins on Page 33

Hume Centrifugally-

The Modern Pipe

Spinning Hume Centrifugal Concrete Pipe—8-foot Sections

WESTERN CONCRE

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Spun Concrete Pipe

For Pressure Lines

DeWITT L. REABURN
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REABURN & BOWEN
CONSULTING ENGINEERS
1104-1107 CENTRAL BUILDING
LOS ANGELES

September 14, 1927.

Western Concrete Pipe Co.,
3025 Fowler St.,
Los Angeles, Cal.

Gentlemen:

We herewith transmit copy of certificate of final acceptance of all the work to be executed under your contract with the City of Riverside, and authorizing the final payment under this contract.

We feel impelled at this time to express our appreciation of the generous spirit of cooperation evinced by your organization throughout the entire construction period. The work performed has been beyond, rather than up to the letter of the specifications. We believe that the success of this intallation of Hume pipe is largely due to the intense pride and interest shown in the work by the personel of your organization.

Very truly yours,

REABURN & BOWEN,

By Edward R. Bowen

EB:W
Enc.

TE PIPE COMPANY

O. 355 CALIFORNIA

"Western Waterworks" Begins on Page 33

Completely welded steel water line recently built by Irrigation District. The above photo shows finished line before placing in the ditch.

Welded Steel Pipe Lines for Water Conveyance Used by Irrigation District

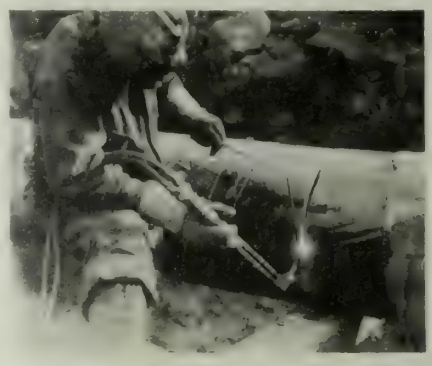
La Mesa Irrigation District Installs Approximately Seven Miles of Welded Lines to be Used for Water Transmission

By G. S. BARRY

THE use of steel pipe with welded connections for conveying oil and gas is an established practice on the Pacific Coast and in the Mid-Continent oil fields. The welded connection forms a convenient, economical and trouble-proof joint, which, once made and tested, can be forgotten. The practice of extending this form of construction to waterworks fields is of comparatively recent origin, but the first jobs of this kind have proven so satisfactory that it is no doubt destined to be used quite commonly in the future construction of domestic water systems and irrigation systems.

Steel pipe provides a greater factor of safety for a given thickness of wall than any other material now in use. It is light, easy to transport and can be relied upon to carry high working pressures without fear of failure. It is resistant to the shock caused by water hammer or vibration of the ground where laid within sufficient cover, and gives the greatest assurance of withstanding earthquake shocks.

When screwed pipe is used it is necessary that the wall be of such thickness that there be sufficient material left after culling the thread to insure ample strength for the joint. Thus the wall thickness of the entire length is generally much heavier than required for the safe operating pressure for which the line is designed.

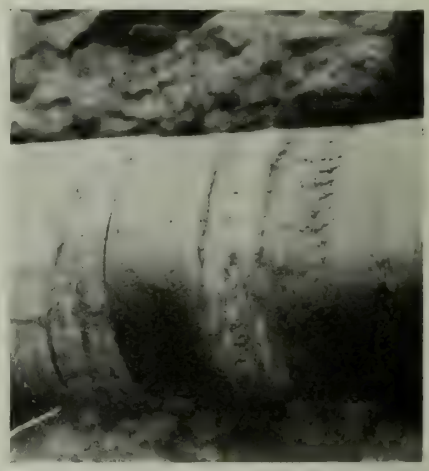


The ends of the pipe are butted together, and welded by means of the oxy-acetylene torch.

By the use of welded connections the full thickness of the pipe wall is maintained, eliminating the objection to threaded pipe where the wall thickness is reduced corresponding to the depth of the thread. Likewise, there are no exposed threads left to form a starting point for corrosion.

By the use of the welded joint or autogenous welding this extra thickness can be eliminated with the result that lap weld pipe with a wall thickness of 1-8 inch to 1-4 inch for size 4 inch and larger is generally ample for the average domestic distributing system or irrigation system.

It is a known fact that all pipe whether steel or cast iron is subject to corrosion under certain conditions and it generally can be said that the rate of corrosion or the time that is required for failure of the pipe is proportional to the wall thickness of the material used. If the pipe is properly protected against corrosion long and satisfactory service is assured. Similarly light weight steel pipe will give as lasting service as heavier pipe if corrosion can be prevented. It can readily be seen that this will be a great saving in the initial cost of a distributing system, as the first cost of the material is lower, handling charges are reduced and the line can be run through localities where it would be impracticable to place heavier material.



The completed weld makes a smooth water tight connection. The cost of a welded line is usually lower than a coupled line.

In the case of the distributing system of the LaMesa Lemon Grove and Spring Valley Irrigation District, large quantities of light weight welded steel pipe were used where the service conditions are the most service. The line was protected from corrosion by the use of a covering of bituminized felt fabric, mechanically applied before the pipe was delivered. The complete protective system consisted of a double coating of petrolastic asphaltum applied under the most modern conditions. After each length had been so treated and thoroughly cooled it was placed in a special power driven machine and wound spirally with waterproof pipe covering, which was ce-

"Western Waterworks" Begins on Page 33

mented to the pipe with an additional quantity of petrolastic asphaltum.

Wrapping Joints

To insure proper adhesion of the covering to the wall of the pipe it is necessary to provide a certain tension on the covering which makes the formation of loose pockets impossible between the pipe

Applying the field covering. Note the four-inch convenience outlet welded into the line.

and the covering. The wrapping covers the entire length of each joint with the exception of 8 or 10 inches at the ends, which are covered with asphaltum after the weld is completed and then hand wrapped with the covering material.

Seven Miles of Pipe

The accompanying photographs of the 18 inch portion of the LaMesa Lemon Grove and Spring Valley Irrigation District Systems show clearly the methods of

Completed joint with field covering applied.

making and covering the field joints. The distribution lines of this district included approximately 5800 feet 18 inch pipe, 7400 feet 16 inch, 6800 feet 14 inch, 6200 feet 12 inch, 1600 feet 10 inch and 7000 feet of 8 inch. Thomas H. King of San Diego was the engineer and Hartley Camp Construction Company of Los Angeles, the pipe line contractors. The pipe was furnished by Crane Company, Los Angeles.

A TYPICAL LACY "JOB" IN THE IRRIGATION COUNTRY

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Manufacturers of

Riveted Steel Pipe From 4 Inches to 10 Feet in Diameter

Originators *of Rust Proof Covering for Metal Pipe*

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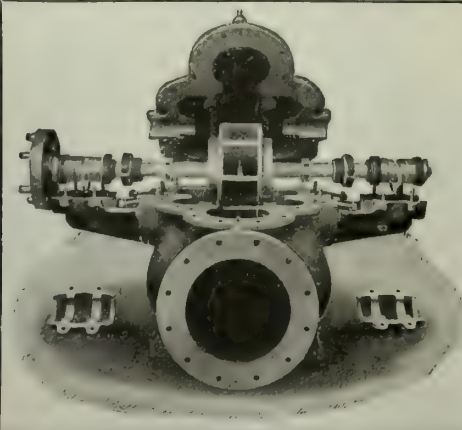

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"Western Waterworks" Begins on Page 33

Interior view of one of the East Bay Municipal Utility District's pumping stations. Pelton pumping equipment is predominant in this installation.

Pumping Plants of Mokelumne Project Fine Example of Engineering Art.

Automatic Synchronous Stop Valves Control Water of Pipe Line in Case of Rupture Anywhere Along Course.

By CURTIS H. MONTGOMERY

THE Mokelumne water supply project of the East Bay Municipal Utility District is not only one of great magnitude, but one in which a wide variety of structures and engineering practise combine to insure delivery, under efficient safeguards, of water for use in eight cities on the eastern shore of San Francisco Bay. The entire development is under the supervision of Arthur P. Davis, chief engineer and general manager of the district.

Water is to be taken from the upper reaches of the Mokelumne river in Calaveras county where a variable radius dam rising 345 feet above the river bed will impound 220,000 acre feet of water at the maximum elevation of 567.5 feet and 204,000 acre feet above elevation 392 feet, the inlet to the aqueduct. Starting at the main storage reservoir, the line leading to San Francisco Bay begins in a concrete-lined pressure tunnel 11,659 feet in length and of 8 foot horse shoe section. At the tunnel outlet the water enters a 65-inch steel pipeline which traverses Calaveras, San Joaquin, Contra Costa and Alameda Counties, a distance of 82.5 miles and connects with a tunnel of 2,435 feet length and 8 foot horseshoe section near Walnut Creek. Emerging from Walnut Creek tunnel the water enters a steel pipe section approximately 18,694 feet in length which in turn connects with a tunnel 16,136 feet long and of 8 foot horseshoe section. A screening chamber is located at the outlet of the last mentioned tunnel on San Pablo creek, this also being the inlet to Claremont tunnel, 18,060 feet in length by 9 foot section and terminating in the city of Oakland.

Laboratory Control

A unique feature of the screening chamber connecting Lafayette and Claremont tunnels will be the installation of flap gates which automatically discharge water into San Pablo creek, as the fluctuating demand in the East Bay cities leaves an excess, which, through this diversion, ultimately find its way to San Pablo reservoir from which point it is distributed as needed in the northerly cities of the district. Most of the water used in the East Bay district will, however, pass through Claremont laboratory at the foot of Claremont tunnel, where control valves, pumping, measuring and chlorinating equipment will be installed.

Provision for the release of flood waters as well as the diversion of water from the main storage reservoir for use of riparian owners is included in the reservoir structures. A spillway of 50,000 second feet capacity will serve the first purpose while a siphon spillway of 16,000 second feet capacity will be built

All of the pumps were thoroughly tested and subjected to a rigid inspection, including hydrostatic and efficiency tests before being sent to the job.

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to provide for diversion as required by the State Division of Water Rights in the lower Mokelumne area. Free discharge regulators are also to be installed in the dam to release water into the Mokelumne stream bed. Such water as may ultimately be used for the generation of 15,000 kilowatts at the dam site will also be discharged into the main stream bed.

Equalizing Reservoirs

A storage of approximately 11,900 acre feet or 3,875,000,000 gallons will be maintained near the town of Lafayette to serve as an equalizing reservoir and also as bypass for water into Upper San Leandro reservoir to the south. Other smaller reservoirs will also be created to serve as equalizers and facilitate distribution to various parts of the East Bay District.

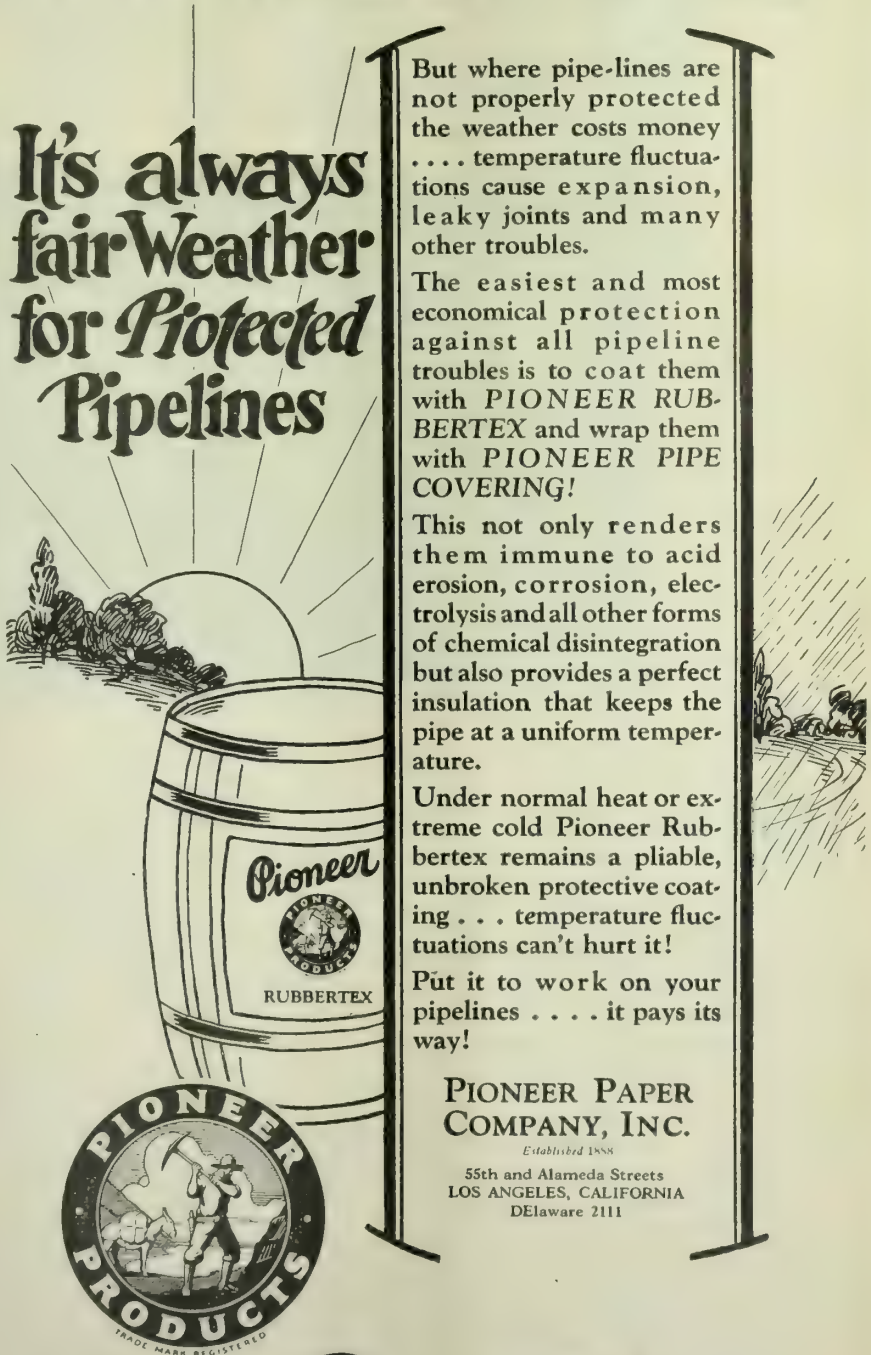
The Walnut Creek pumping plant, the size and cost of which is insignificant when compared with other features of the Mokelumne project is in reality one of the most important parts of the system, being located 1¾ miles north of Walnut Creek. The purpose of this plant is to increase the capacity of the long aqueduct as necessary to supply the requirements of the district, the pumps installed being operated to regain the pressure lost through pipe friction. With the surface of the upper reservoir at 567.5 feet approximately 37,000,000 gallons per day will be delivered at Walnut Creek tunnel by gravity flow, this volume diminishing as the water level in the reservoir recedes.

It is estimated that with water in the reservoir at elevation 520 feet the capacity of the pipeline at Walnut Creek tunnel will be 31,000,000 gallons per day without the use of pumps. Thus it will be seen that operation of the pumps will probably be necessary during the season of low water at the reservoir to supply present demands, whereas full time operation of several pumping units may be necessary in later years to supply the increased demands. As an indication of the importance of the Walnut Creek pumping plant to this system, it is estimated that the pipeline capacity will be increased from 31,000,000 to 60,000,000 gallons per day by operation of two units in the Walnut Creek plant with the reservoir elevation at 520 feet.

Pumping Plants

Three complete pumping units have already been installed in the Walnut Creek plant, each consisting of two series connected 24-inch centrifugal pumps designed and built by The Pelton Water Wheel Company of San Francisco. The two pumps comprising a unit are mount-

(*Continued on Page 54*)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But where pipe-lines are not properly protected the weather costs money .... temperature fluctuations cause expansion, leaky joints and many other troubles.
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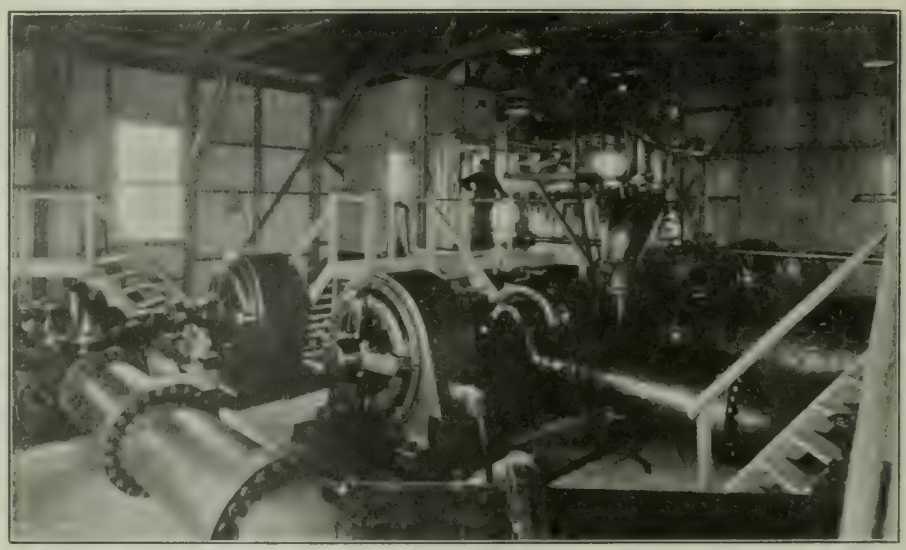
"Western Waterworks" Begins on Page 33

DeLaval Centrifugal Pumps

You are cordially invited to visit our exhibit at the Water Works Convention at San Jose, October 5, 6, 7 and 8, 1927.



THREE sixteen-inch, double suction, single stage De Laval Pumps at the Bay Pulgas Station of the Spring Valley Water Company, serving the City of San Francisco.

These pumps operate as boosters on the final section of the Hetch-Hetchy system, delivering at present, the Calaveras water supply to the Crystal Springs Reservoirs in San Mateo County.

The pumps were designed to give maximum possible efficiency when operating singly or in group. The capacity of this station, under varying demands for water, is:—

With one pump operating.....15 M. G. D. against 138 ft. head
With two pumps operating.....26 M. G. D. against 178 ft. head
With three pumps operating.....30 M. G. D. against 213 ft. head

In continuous service since starting, these pumps have delivered 34 million gallons daily.

Other California Municipalities served by De Laval Centrifugal Pumps:—

City of Brea.
City of El Centro.
City of Healdsburg.
City of Glendale.
City of Laguna Beach.
City of Los Angeles.
La Mesa, Lemon Grove, and Spring Valley Irrigation District.
Los Angeles Water Service Co.
City of Marysville.
City of Montebello.
City of Oakland.

The fact that more than 200 other American Cities use De Laval centrifugal pumps of a total daily capacity of over 8,000,000,000 gallons, many of them purchased on repeat orders, is attributable to their high duty, low first cost, low cost for attendance and supplies, saving in building and foundation costs, and uninterrupted service.

City of Pasadena.
City of Red Bluff.
City of Redding.
City of Redondo Beach.
City of Sacramento.
City of San Francisco
City of Santa Cruz.
City of South Pasadena.
City of Vernon.
Cities in Contra Costa County system of California Water Service Corporation.

DeLAVAL STEAM TURBINE CO.

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Manufacturers of Steam Turbines, Centrifugal Pumps, Centrifugal Blowers and Compressors, Double Helical Speed Reducing Gears, Worm Gears, Hydraulic Turbines, Flexible Couplings and Special Centrifugal Machinery

"Western Waterworks" Begins on Page 33

WESTERN
Waterworks
Supplement to Modern Irrigation
Of Interest Expressly to Waterworks Executives, Contractors, and Municipal Engineers

San Jose Host to California Section, A. W. W. A. During Eighth Annual Convention

SAN JOSE is the destination this year of the annual trek of the members of the California Section of the American Water Works Association. The eighth annual convention will be held October 5-8, with headquarters at Hotels Sainte Claire and Vendome. Judging from reservations already made, the attendance wil be even larger than that at San Diego last year, which broke all previous records.

The Committees in charge say that the 1927 convention will be a record breaker in entertainment features as well. They have spent months of careful planning and offer a program of technical sessions, discussions, practical demonstrations, and entertainments which they believe will make the session the most interesting and valuable yet held.

The Program

WEDNESDAY, OCTOBER 5, 1927

All day session, Golf Tournament and general get-together.

THURSDAY, OCTOBER 6, 1927

Forenoon, 10:00 A.M.: Auditorium, Scottish Rite Temple. General get-together, registration and review of Manufacturers' Exhibits.

Afternoon, 2:00 P. M.: Address of Welcome by C. D. Goodwin, City Manager of San Jose.

2:15 P. M.: Description of San Jose Water Works System, Joseph R. Ryland, President, San Jose Water Company.

2:45 P.M.: Gunite Covered Steel Pipe and Centrifugal Concrete Pipe for Laguna Beach Water District. Edgar Allan Rowe, Associate Engineer, Engineering offices of J. B. Lippincott.

3:10 P.M.: General Discussion.

3:20 P.M.: Five Minute Paper on: Simple Methods of Taking Flow Tests from Fire Plugs, Robert C. Stange, National Board of Fire Underwriters.

3:25 P.M.: Symposium on The Present Practice in Cross Connection—Discussion of view of: State Board of Health, Edward A. Reinke; East Bay Water Company, Joseph De Costa; Pasadena Water Department, Morris S. Jones; Los Angeles Water Department; California Water Service Company, E. K. Barnum.

4:00 P.M.: Method devised for removal of sulphur from Well Water, Arthur Taylor, Consulting Engineer, Los Angeles.

Evening, 6:30 P.M.: Informal Dinner, Hotel Sainte Claire. Business Meeting: Discussion—Revision of Water Works Manual, Reports of Retiring Officers, Reports of Committees, Election of New Officers, Selection of next place of meeting. Address by Senator James D. Phelan.

FRIDAY, OCTOBER 7, 1927

Forenoon, 10:00 A.M.: Symposium on Watershed Protection, Discussion of View of:
Marin County Water Dept., John Burt, Gen'l. Mgr.
Spring Valley Water Co., George J. Davis, Supt., Peninsula System.
East Bay Water Company, George W. Hawley, Ass't. Chief Engr.
San Diego Water Dept., R. G. Wueste.
San Bernardino, William Starke, Supt.
Los Angeles, Dr. Carl Wilson, Director, Biological Laboratory.
State Board of Health, Ray F. Goudey, Sanitary Engineer.

10:45 A.M.: Symposium on Water Main Installation Methods, A. W. W. A. Spec. Cast Iron Pipe, Lead, Cement, Non-caulking Compounds. Lighter Grades of Cast Iron Pipe, Dalevard, Monocast and McWane. Riveted Steel. Welded Steel.

11:30 A.M.: Paper by I. E. Flaa, Assistant Engineer, Spring Valley Water Co. Subject "Various Waterworks Jobs for 1927."

1:30 P.M.: Lodge Room, Scottish Rite Temple. "Description of centrifugally cast high pressure pipe line for the City of Riverside." Illustrated with motion pictures. Given by Edward R. Bowen, Consulting Engineer, Reaburn and Bowen, Los Angeles.

Afternoon, 2:00 P.M.: St. James Park (Directly across street from Convention Auditorium) Practical field demonstration of Modern Water Works Practice such as Welding fittings, large taps under pressure, cement joints, etc, led by L. L. Farrell, Superintendent of Distribution, East Bay Water Company.

All Water Works Superintendents and Engineers are requested to bring samples of any small tools, supplies or equipment devised by them for exhibition at this meeting.

Evening, 6:30 P.M.: Dinner Dance, Informal, at the Hotel Vendome, as guests of the Exhibitors. Special entertainment by Arthur Terry, Cowboy Monologist and selections by the "Orpheus Four."

SATURDAY, OCTOBER 8TH

Forenoon to Afternoon, 10:00 A.M.: Auto trip and barbecue, trip about San Jose watersheds with luncheon as guests of San Jose Water Company.

FOR THE LADIES

The ladies' entertainment will receive especial attention. A special Reception Committee of ladies will assist as hostesses. Several novel features are proposed for their enjoyment. On Friday evening and Saturday the ladies will participate with the members in the regular program of the convention.

The exhibits planned for this convention are expected to surpass those of previous sessions in both interest and number. The Scottish Rite Auditorium will house the exhibits and will be the meeting place for the assembly.

A novel feature of the program is a practical field demonstration of modern water works practice, such as welding fittings, making large taps under pressure, cement joints, etc., wil be held by L. L. Farrel, superintendent of distribution, East Bay Water Company. This is cheduled for Friday afternoon and will take place in St. James Park, directly across from the convention auditorium. All water works superintendents and engineers are requested to bring samples of any small tools, supplies or equipment devised by them for exhibition at this session.

The plan of having general discussions on two or three subjects of particular interest to waterwarks men, which has been so successful in recent meetings, will be followed again this year. A symposium on "Present Practices in Cross Connections" will be led by Edward A. Reinke of the California State Board of Health: one on "Watershed Protection" will be led by John Burt, general manager of the Marin County Water Department, "Water Main Installation Methods" will also be discussed.

By way of general entertainment, a golf tournament has been scheduled for Wednesday, October 5. The annual dinner dance, given by the exhibitors, will be held Friday evening at the Hotel

(Continued on Page 81)

East Bay Water Shortage Menace Eliminated by Partial Completion of Aqueduct

Section Between Old River and San Pablo Creek Rushed to Completion as Emergency Measure in Case 1927 Should Be Dry Year

By ARTHUR P. DAVIS

Chief Engineer and Manager East Bay Municipal Utility District

FOR many years past, the region east of San Francisco Bay has been in a precarious condition regarding its water supply. A severe shortage resulting in financial loss occurred in 1918, and a recurrence of this water shortage has been threatened ever since. Additional reservoirs which have been built have never been filled, as their water sheds are small. To obviate water shortage, pumping has been increased from the gravels to the south of the district, and the water table in that region has been lowered to a point 25 or 30 feet below sea level. Salt water has invaded some of the wells and others are threatened. The disastrous fire in the city of Berkeley in 1923 was due in part to the inadequate water system.

Realizing the gravity of the situation, nine cities on the eastern shore of San Francisco Bay, namely: Oakland, Berkeley, Alameda, Richmond, San Leandro, Piedmont, Albany, Emeryville, and El Cerrito, in 1923 organized themselves into a municipal utility district, under the State laws for the purpose of bringing an additional supply of pure water from the mountains.

It was impossible under existing law to secure any funds for field work until the first of July, 1924, but a large force was placed in the field on that date, and surveys were made on four different projects. In September of 1924, the Mokelumne Project was officially selected, and on November 4th of the same year the voters of the district authorized the issue of $39,000,000 in bonds for constructing the system. This bond issue was contested by several opponents of the project, and it was not until September, 1925 that it was finally validated. Immediately thereafter contracts were let for the most urgent portions of the system, which consisted of an aqueduct reaching from Old River to San Pablo Creek,—the plan being to complete this portion in time for pumping in the spring of 1927, in case that should be a very dry year. This portion of the aqueduct was duly completed in May of 1927, and could have been used during that year for providing for an emergency supply from Old River to San Pablo reservoir, but the abnormal precipitation of that spring accumulated water in the reservoirs to an extent that obviated the necessity of an emergency supply.

The project as outlined consists of a large reservoir on the Mokelumne River, about five miles north of the town of Valley Springs, which is the nearest railroad point. The dam will be 360 feet in height and will impound about 230,000 acre feet of water.

Some conception of the size of the sixty-five-inch pipe line can be obtained from the above picture. The gentleman at the left is A. P. Davis, chief engineer and general manager of the project.

As originally designed, this dam was to be built in the form of an arch, with variable radius depending upon the arch action for its stability. Subsequent developments, however, in piercing the abutments by tunnels, disclosed fractures to such depth that the site became too wide for economical use of the arch form, and it was therefore changed to a gravity design, curved in plan to a radius of 1200 feet.

For several miles below the dam the canyon is so steep and tortuous as to require the construction of the aqueduct in tunnel. This tunnel will leave the reservoir about 1000 feet southeast of the

dam and will be 11,660 feet in length. It will operate under a full head of water in the reservoir, and will be reinforced to take a hydraulic pressure of 185 feet head.

The reservoir will be provided with two spillways. A gap to the south occurring between the outlet tunnel and the dam will be closed by a structure which will be a combination of weir and siphon spillway, designed to permit storage in the reservoir to an elevation of 570 and to discharge all flood waters above this point. This spillway, however, will be controlled so as to force all flood waters, or any part thereof desired, to discharge to the northward over another spillway.

Arroyo Seco Reservoir

The other spillway to the northward will have a capacity of 18,000 second feet, through which water may be forced up to its capacity, and from which it will run into Jackson Creek, otherwise known as Arroyo Seco. On the latter creek occurs a proposed reservoir site known as the Arroyo Seco Reservoir, and plans have been made by irrigation interests to build a large reservoir here for which the present water supply will be the overflow from the district's reservoir on the Mokelumne. The Pardee Reservoir therefore becomes a very important feature in the development of irrigation by furnishing the main water supply to this large reservoir.

The permit from the State Division of Water Rights contains the requirement that surplus water be discharged to the northward whenever demanded by the interests of the people therein, for their use.

One mile southwest of Lafayette a balancing reservoir is being constructed to have a storage capacity of 11,980 acre feet. Its surface will be 500 feet above sea level and the dam will contain about 2,000,000 cubic yards of earth and other materials. Its principal function is to serve as an emergency storage to provide water in case of a break in the aqueduct, and give time to repair such break. At the present rate of consumption of the district, this reservoir would be sufficient to furnish a supply for nearly five months. It will normally be kept full of water, to be used only in case of emergency. Water must be pumped into this reservoir from the aqueduct, but will flow therefrom by gravity through the Lafayette and Claremont tunnels into the heart of the district.

In the vicinity of the Walnut Creek Pumping Plant, a double pipe line has been installed.

The Lancha Plana Dam Site, looking up-stream.

Course of Pipe Line

From the outlet of the reservoir a pipe runs in a nearly straight line for a distance of 37 miles southwesterly to Holt. From this point, the pipe parallels the Santa Fe Railroad for 11 miles in a westerly direction to Bixler, and continues in a general northwesterly direction 24 miles to Bay Point. Here, it abruptly changes its course to the southwestward for a distance of 10½ miles to the Walnut Creek Tunnel, which pierces a spur of the Coast Range. This tunnel is about one-half mile in length.

A reinforced concrete conduit 3½ miles in length extends from Walnut Creek to the Lafayette Tunnel, which pierces another spur of the Coast Range and emerges into San Pablo Creek. This tunnel is three miles in length and its water may be discharged into San Pablo Creek, or the water may be carried under the creek through another tunnel which emerges into Temescal Canyon near the line between Berkeley and Oakland.

The three miles of concrete aqueduct and all the tunnels have an estimated capacity of 310 second feet, or 200,000,000 gallons per day.

Gravity or Pressure Flow Optional

The pressure pipe across the San Joaquin Valley, which has a total length of

(*Continued on Page 44*)

Chlorinating Plants of Spring Valley Company Located at Three Main Sources of Supply

Treatment of San Francisco's Water Supply Undertaken by Modern Chlorinating Apparatus Located on Three Main Transmission Lines

By G. J. DAVIS
Superintendent, Peninsula System

FOR the past sixty years the Spring Valley Water Company has supplied the City of San Francisco with water. The supply comes from several storage reservoirs in San Mateo County, one reservoir in Alameda County and a varying amount from wells and creeks in Alameda County.

The watershed areas are practically all owned by the Water Company while the few exceptions are under control, which render chances of pollution remote. The few scattered homes are inhabited by company watchmen. Samples of water have been taken consistently at regular intervals and a close observation of the lakes kept with satisfactory results. No epidemics have occurred, the cause of which, could be even remotely traced to the water supply.

About four years ago, chlorinating plants were started at the distributing reservoirs in San Francisco and at Sunol, to fulfill the requirements of the State Board of Health and as a precaution against any possible contamination. Two years later the stations were changed to the sources of supply.

Three Main Transmission Lines

The three transmission lines conveying water to the city are known as the Alameda, Crystal Springs and San Andreas transmission lines. The chlorine plants are installed to treat the water as it enters these lines.

The first chlorinating station installed by the Water Company in San Mateo County was at the Belmont Pumping plant. From this station fifteen to twenty-one million gallons of water per day are pumped through the Alameda line. The chlorine plant is installed on a concrete forebay, from which the water passes through a thirty-six inch pipe to the pumps. This location was selected as being the most convenient for the treatment, as all of the water flowing to the pumps passes this point at a constant rate and being an open forebay, there are no pressure difficulties with which to contend. The forebay is cylindrical in shape, twenty feet in diameter with walls 24 inches thick. The top slab is 4 inches in thickness and is supported by reinforced concrete and steel beams, capable of carrying a floor load of about two tons.

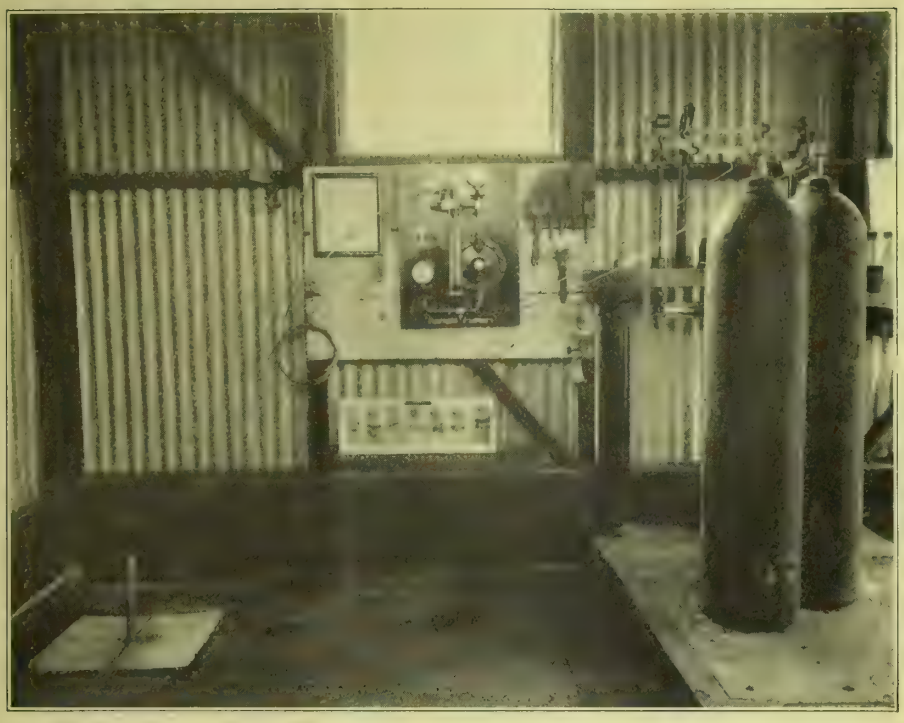
Interior View of the Belmont Chlorinating Plant. This Plant is Similar to the Crystal Springs Chlorinating Station Shown on Opposite Page.

The shelter is a frame building, with rustic outside, lined with T and G inside, 14 feet square, 8 feet high, built over the concrete slab. The building has two windows and is painted inside with white enamel for lighting effect. The structure is also wired for electric lighting at night. Protection of the chlorine apparatus from cold is very important. A steam radiator, fed by a pipe direct from the boiler room, is used for heating, as it is necessary to keep the temperature above 60 degrees Fahrenheit for satisfactory operating.

Chlorine Equipment

When first operated, chlorine was purchased in 150 lb. steel containers. A number of these were grouped together on platform scales and connected to chlorinator with separate flexible metal tubes from each tank to a manifold. The scales are used to check against the indicator on the instrument for quantity of chlorine used, also for registering the amount in the tanks ready to feed chlorinator. Observations of these weights and records are made at this station nine times during twenty-four hours, each operator having to register the results three times during his eight hour shift.

The solution from the chlorinator is conveyed through a special chlorine resistant hose to the point of application at the center of the thirty-six inch pipe leading from the forebay. The base is protected from injury and held in position by a 2 inch metal conduit which extends from the case of the instrument to within a few inches of the end of the



Interior View of Crystal Springs Chlorinating Plant. Note the Use of the One Ton Containers in this Installation.

hose, care being taken to see that the hose is projecting beyond the pipe to avoid corrosion, the action of the solution being very rapid.

After a few months it was found that the chlorine obtained in larger containers would be more satisfactory and the company proceeded to obtain chlorine in one-ton containers. Besides a considerable saving in cost of chlorine, the number of valves used for supply are less and naturally a smaller chance for leaks and the number of times of changing the tanks considerably reduced. The weight of the empty one-ton container is approximately 1,300 pounds.

Use of One Ton Containers

To take care of the additional load on the cover of the forebay, two 8 inch I beams, long enough to span the outside walls of the well, were set, and the platform scales of 3,500 pounds capacity were placed on them. A runway was then built level with the platform of the scales, and extended on two sides of the building to allow for loading and unloading of tanks from automobile trucks. Special doors were built on both sides of the house so that the full tanks, with a gross weight of 3,300 pounds could be rolled through from one side of the building and placed on the scales and passed out at the opposite door when empty. Sufficient space is provided inside the building for two full tanks in addition to the one on the scales.

The quantity of chlorine used so far has varied from one to five pounds per million gallons of water. Color tests are made at intervals during the day by the use of ortho-tolidin to determine the residual chlorine in the water after ten minutes flow from the pumps. The heaviest dosing is done during the winter months when the water is more turbid. In addition to the residual chlorine tests made by the operator of the plant, bacteriological examinations of raw and treated water are made by the State and San Francisco departments of health.

The second station put into use takes care of the San Andreas pipe line, and is installed at the outlet of the tunnel from the San Andreas reservoir. The tunnel feeds into the line, through a measuring box, a quantity of water varying from seven to twenty-three million gallons per day.

The equipment was installed in an existing shelter over the tank. The type of chlorinator used is known as the Wallace & Tiernan Company, M.D.A. and feeds dry chlorine directly into the open tank through two diffusers, submerged in three feet of water. At this station, 150 pound chlorine tanks are used on account of the inaccessibility of the location, being situated on a steep sidehill. Platform scales of 3,500 pounds capacity are used for weighing the tanks which are grouped in two or three. As neither steam nor electricity is available at this plant the temperature is taken care of by means of coal oil heaters.

Our third station is located at the outlet of the Crystal Springs Reservoir. At this location is an electrically operated booster pump with a capacity of 26 million gallons per day, which pumps into the Crystal Springs transmission line; also a turbine pump used to elevate water from the Crystal Springs Reservoir to the San Andreas Reservoir, through a combination pipe and flume conduit. The chlorine plant at this station is equipped to treat the water entering the Crystal Springs pipe only, as any water pumped through the other channel to Lake San Andreas would be treated on leaving that reservoir.

The chlorine plant in installed in a separate building adjoining the pumphouse and consists of a 12-foot by 22-foot structure with a board and batten outside and T and G lumber inside. This house was built with the idea of using one ton chlorine containers and one side was enclosed by three sliding doors. The location of the chlorine house makes it impossible to handle the tanks directly from the automobile trucks as at Belmont, so a track about 60 feet long was built from the chlorine house to the roadway over which a small

Interior View of the San Andreas Plant. This is Located at the Outlet of the Tunnel from the San Andreas Reservoir.

car travels with the tank to the storage space or to the scales. Empty tanks are handled in the same manner.

The type of chlorinator used at this station is known as the Wallace & Tiernan Company, M.D.A.M., which feeds dry chlorine into an injecting apparatus, operated by a water pressure of 140

(Continued on Page 56)

By the use of a portable Universal Crane, the progress of pipe laying was very rapid. The above view shows the placing of the pipe sections in the ditch.

New High Pressure Concrete Water Line Completed by Riverside

Actual Leakage Loss on Seven Mile Section Only 17 Percent of That Permissible by Specifications

By EDWARD R. BOWEN

Of Reaburn & Bowen, Consulting Engineers, Los Angeles

THERE has just been completed by the contractors, a very interesting installation consisting of approximately eight miles of 42-inch Hume centrifugally cast reinforced concrete pipe for the City of Riverside, California. This pipe line was designed to operate under a maximum pressure of 105 feet. The method of construction and pipe fabrication was described in detail in an article published in the May, 1927, issue of MODERN IRRIGATION.

Since that article was written, the entire contract has been completed and the installation tested under a hydrostatic pressure substantially in excess of the operating line pressure. About 35,000 feet of pipe were tested in one section for a period of four hours. The leakage was measured through a 1-inch trident meter. Pressure was maintained constant through a pressure regulator and was such as to subject the 105-foot head pipe to 137 per cent of the normal pressure; the 93-foot head pipe to 142 per cent; the 75-foot head pipe to 152 per cent; and the 50-foot head pipe to 178 per cent of the normal operating pressure. The specifications permitted leakage of 200 gallons per inch of diameter per mile of pipe per day, and the actual test showed amounted to 1256 cubic feet or at the rate of 34 gallons per inch of diameter per mile of pipe per day. This is about 17 per cent of the leakage permissible. The result of this test, together with the fact that there was not a single bad field joint developed in the entire installation, leads to the conclusion that the methods adopted for the joint construction and installation are well advised and successful.

In the writer's judgment, the success of the field joints is largely due to the fact that the pointing on the inside of the pipe was done after the line had been backfilled and the ditch water settled. The pipe had then obtained an even temperature and was not subjected to stress resulting from wide temperature variations between night and day. As soon as practicable, after a section of line had been completed, a most careful inspection was made, inside the pipe, of all the joints, and it was filled with water. Any hair cracks were readily discernible and were cut out and repointed before the water was turned in.

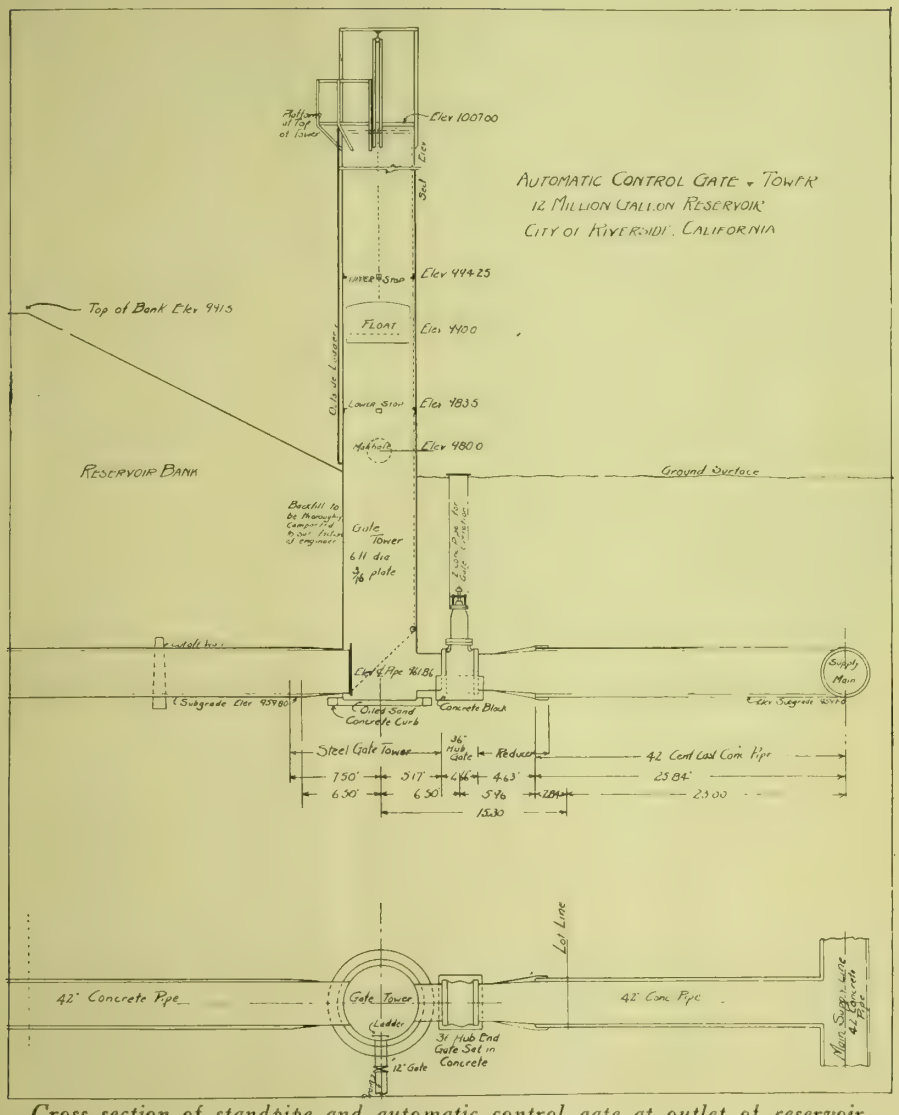
RESERVOIR CONSTRUCTION

The twelve million gallon water storage reservoir, forming a part of this project, is of the excavation and fill type with a balanced yardage. The design of the reservoir lays great stress upon the consolidation of the fill. The lining is two inches of gunite and has little structural strength. Under these conditions, it was of primary importance that the fill should be carefully built and thoroughly compacted. The material was a sandy loam containing about twenty per cent clay.

The excavation extended six feet back of the finished line on the slopes and sixteen inches below finished subgrade on the bottom. The excess excavation on the sides was refilled to two feet beyond or inside of the finished line, and the excess fill then trimmed and consolidated over the bottom of the reservoir. The excavation was made by a B. & H. gasoline drag line, loaded into trucks and distributed in 4-inch layers around the embankment. The loaded truck made a complete circuit of the embankment before dumping, care being taken to avoid any multiple tracking of the trucks. Three or four one-inch hose streams were kept playing on the embankment at all times. The amount of water was carefully limited to the point where the fill would not creep in front of the loaded truck wheels.

By this method, the entire surface of the embankment was given a rolling and compacting from the wheels of the loaded truck. In addition to this compacting, two sheepsfoot tampers drawn by Fordsons were operated continuously. The efficacy of this latter equipment is doubt-

Centering and landing the pipe sections in the ditch.



Cross section of standpipe and automatic control gate at outlet of reservoir.

ful, however, inasmuch as the compacting of the truck wheels was so great that the feet of the tampers would penetrate only about three-fourths of an inch. Frequent test holes were dug in the fill as it progressed. It was consistently found that the fill could be shoveled out to a depth of about eight or ten inches below the working surface but that beyond this depth it was necessary to use a pick. The character of the fill was also demonstrated in trimming the sides. The finished trim was made by hand with grubbing hoes, and left the surface hard and unyielding. The shrinkage was about 15 per cent.

The roof was started as soon as the fill was completed. It consists of 4x4-inch girders spaced 21 feet 6-inch centers with a 17.5-foot span supporting 2x8-inch joists spaced 24-foot centers. It was tight sheathed and covered with an 85-pound felt roofing paper. The supporting columns were precast reinforced concrete 8x8-inch square and 25 feet long.

After the roof was constructed over about one-third of the reservoir, the gunite lining was started under the roof. The gunite was a one to three and one-half mix, two inches thick and reinforced with welded wire fabric with 6x6 mesh and No. 6 wire both ways.

The completed gunite sections were kept constantly wet with water and the hot humid atmosphere resulting under the roof made the curing conditions ideal. The reservoir has been completed and the floor and side walls carefully inspected. No shrinkage cracks have been found and it is anticipated that when it is filled with water, it will be practically bottle tight.

Reservoir Floats on Line

The elevation of the intake at the supply line feeding the reservoir is 1005 feet. The elevation of high water in the reservoir is 990 feet. It is desirable to "float" the reservoir on the supply line and the main distribution line leading from the reservoir into the city. In order to accomplish this, it was necessary to devise some automatic control which would shut off the reservoir when the pressure in the supply line at the point of delivery reached the elevation of high water in the reservoir.

The inlet and outlet for the reservoir is effected through a single 42-inch centrifugally cast concrete pipe extending underneath the bottom along the longitudinal axis for the entire length of the reservoir. This line is tapped into the bottom of the reservoir through a series of small holes. Circulation is effected by this method of delivery and withdrawal.

The inlet and outlet pipe is attached to a vertical steel pipe 6 feet in diameter, extending to an elevation 2 feet above the elevation of the intake of the supply line. A Calco drainage gate is attached to the reservoir outlet pipe on the inside of the vertical steel pipe. The Calco drainage gate is equipped with bronze bushings on all hinges. The other side of the vertical steel pipe has free access to the supply line. The Calco drainage gate is attached by a cable operating through shives with bronze bushing to a steel float suspended inside of the vertical steel pipe. The arrangement is shown on the accompanying sketch.

When the reservoir is empty the steel float is at its lowest position and the Calco gate is open. As the water rises, in the reservoir, it also rises in the vertical steel pipe raising the float and lowering the drainage gate. The cable between the float and the gate operates through multiple blocks so that a small movement of the float produces a large movement in the gate. The length of cable is so adjusted that when the reservoir has reached its high water level the Calco gate is closed. As the pressure in the supply line increases above the high water level, the water simply rises in the vertical steel pipe. As the pressure in the supply line diminishes, the process is reversed.

Main Distribution Line

The greater part of the line leading from the reservoir into the City of Riverside is 36-inch and 30-inch x 3-16-inch welded steel pipe encased in 3-4-inch gunite jacket. This type of construction is the same as that adopted and successfully used on the Laguna Beach job. The extremely hot weather during which it was necessary to gunite the pipe made the curing difficult. The guniting process was carried on in the early morning, from 3:30 to about 10 or 11 o'clock. The pipe was carefully cooled with water before any gunite was placed on it, covered with burlap immediately upon completion and kept constantly wet for a period

(Continued on Page 70)

Looking down stream at the site of the Bull Run Dam. The finished elevation of the structure is shown by the white line.

Construction Features of Bull Run Dam

New and Unusual Construction Methods are Being Utilized by Builder of Exchequer Dam in New Project

By B. E. TORPEN

Superintendent of Design and Construction of Bull Run Storage Project

THE construction plant at Bull Run Dam for the City of Portland, Oregon, has been carefully planned by the constractors, Bent Bros., Inc., of Los Angeles. First class equipment, highly motorized and automatic where possible, enables the work to be carried on with a minimum of labor. Manufacture of concrete aggregates, dam excavation and dam concrete operations will be continuous throughout the period of construction.

The camp is situated on a convenient bench 100 feet in elevation above the crest of the dam and consists of the usual office, mess, commissary, and quarters. Here also are located the form building plant and carpenter shop, and the machine shop, conveniently located under the cableway. The camp is within the watershed reserve and the only means of access is by auto, the nearest railroad station being 10 miles distant. Supplies, materials, steel, valves, lumber, and cement are hauled in over a gravel road by a subconstractor using 5-ton Mack trucks.

Twelve hundred horse-power for lighting and motors is supplied by a 10 mile transmission line at 11,000 volts stepped down for motors to 440 volts.

Excavation consists of 100,000 cubic yards of material evenly distributed between common excavation and rock, and is made with two P & H, 1½ yard gas electric shovels and 5-ton Mack trucks.

An earth fill coffer dam was constructed 100 feet upsteam with the materials excavated from the lower sidewalls and the stream diverted during low flow of 200 cubic feet per second through a 6'x9'x800 feet flume. The river bed was overlain with only 10 feet of river gravel and very little work was required to leave this in first class condition to receive concrete.

A cut-off trench 10 feet wide x 6 feet deep was excavated at the heel of the dam and a 30 foot strip was excavated 2 feet into the rock near the heel and at the downstream toe for better bond, shear, and bearing. The rest of the bed rock, with wavy and irregular surface, was scrupulously cleaned and scrubbed and flooded with cement grout to secure a water-tight joint.

Grout Holes

In the bottom of the cut-off trench 2-inch by 50 feet grout holes were diamond drilled by Lynch Bros., of Seattle, under sub-contract. The holes in the river channel all struck artesian water at pressure varying from 70 pounds to 10 pounds per square inch. Cement-grout composed of 1 to 6 or 1 to 4 was forced into these holes at 100 pounds pressure to refusal with a Ransome grout machine. Downstream from the grout holes a row of drain holes were drilled to relieve uplift and the water carried up into the inspection tunnel which runs the full length of the dam. Total air compressor capacity on the job for jack-hammer drilling, rock drill, dia-

A view showing the excavations made on the south wall of the channel. The screening and gravel washing plant is shown in the foreground. Aggregate bins below accommodate five sizes of material, from sand to 9-inch gravel.

mond drilling, grouting was 1,200 cubic feet per minute.

Concrete Aggregates

Concrete aggregates are secured from river gravel bars three miles below the dam, where a 100-ton Monighan dragline, 50-foot boom, 2½-yard Page bucket loads into 12-yard Western, air, side dump cars. Three 18-ton, standard gage, Vulcan locomotives haul 2 to 3 cars each and make a round trip each hour. Cars dump in a hopper from where a 200-foot 30 inch belt conveyor lifts the material to the screen.

A Bodinson revolving screen and mechanical sand washer grade the aggregates into five sizes, from sand to 9-inch gravel, all of which are measured through two sets of aggra-meters under the bunkers into two Insley side dump charging cars. The grading of the aggregate when necessary is regulated by a large aggregate and a sand crusher. The sand is measured in Blaw-Knox Innundators and an interesting feature is the necessity for dehydration on account of the low cement content of the concrete, about 10 gallons of water being drawn off from each batch at the innundator.

A 4-ton Plymouth gas locomotive hauls the charging cars 100 feet to the charging hoppers where the batches containing water, sand, and gravel are dumped directly into two 2-yard Smith mixers simultaneously with the cement which comes through chutes from the floor of the cement shed directly above. In this manner no water is lost through leaky gates and the consistency of the mix is kept uniform to the desired slump of 4 inches.

Forms set for penstocks, preparatory to the pouring of concrete. The mixing plant may be seen at the right of the picture.

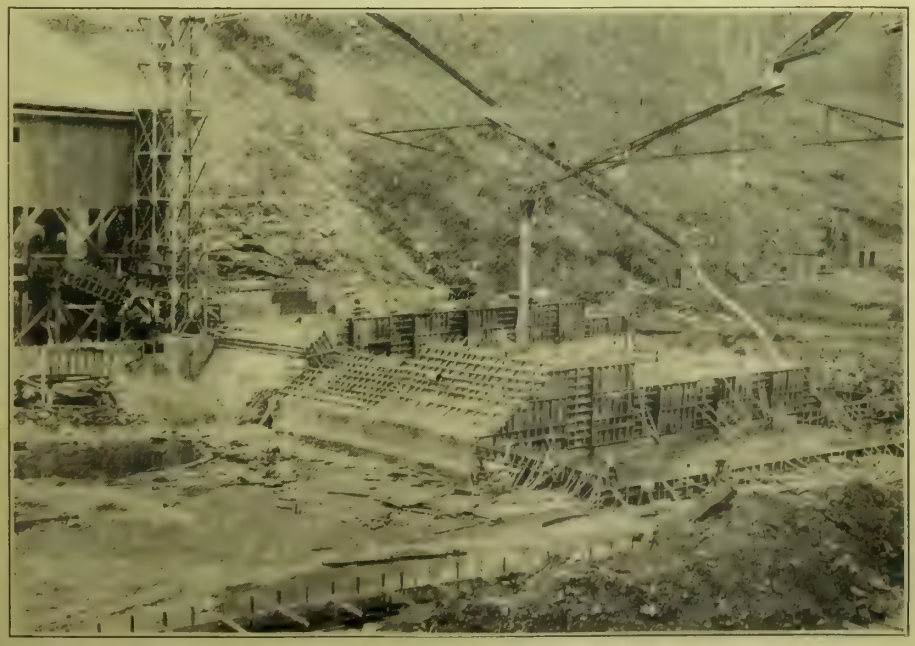
Mixing and Placing Concrete

The total yardage to be placed is about 230,000 cubic yards and is being placed at the rate of 600 yards per shift. Time of mix is two minutes and only 2½ minutes elapse between batches. The mixers dump directly into skips in a double compartment Insley steel tower 375 feet high. Two 150 H. P. Thomas hoists raise the skips at a speed of 600 feet per minute to 2-yard hoppers and 20-inch chutes which serve the whole dam through 60 foot counterweighted chutes and elephant trunks.

The concrete mix of about 1 to 9 is used with a 4 inch slump (.8 bbl. cement per cubic yard of concrete), and a w/c of slightly less than 1.0 gives a 28 day strength of 1,500 pounds per square inch. Over 30 per cent of the aggregate is cobbles, 3-inch to 9-inch. The practical maximum size is over 6-inch and the fineness modulus of the coarse aggregate is over 9.0 which is believed to be the coarsest aggregate ever passed through mixers. The effect of such a large proportion of coarse aggregate is to increase the unit weight, strength and impermeability of the concrete. The City maintains on the job a laboratory with full field equipment including a 100,000 pound hydraulic crushing machine for testing cement, concrete, and for concrete design and control.

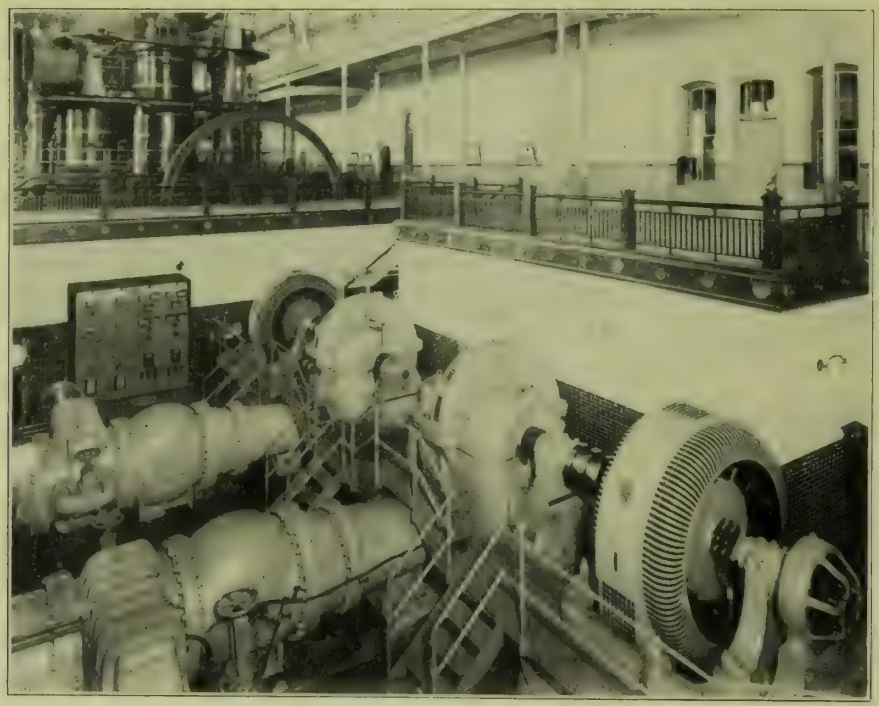
Some details of form work and placing concrete are: panel form system used; key ways on 4 foot lift horizontal work joints and on each vertical contraction joint which are spaced 40 feet; 4-inch vertical and horizontal drain tile throughout the structure; 24-inch copper sheet-metal water stops near the upstream face; and placing the concrete as nearly normal as practicable to the principal stresses.

The personnel on the job for the contractor consists of L. T. Grider, general superintendent; K. L. Parker, superintendent; and H. A. Hamlin, business manager.



The first concrete was placed on August 12, 1927. The above picture shows a portion of the structure already completed, this photo having been taken August 29, 1927.

STORAGE & DISTRIBUTION



Two motor-driven Centrifugal pumping Units, one designed to handle 50 M.G.D. and the other 70 M.G.D.

New Motor-Driven Centrifugal Pumping Unit Shows High Efficiency

Centrifugal Pump Manufacturer Designs Direct Connected Units Whose Characteristics Were Predetermined from Model

By L. E. BRIDGE

WATER for the City of Detroit, Michigan, is pumped by two pumping stations, known as stations No. 1 and No. 2. Station No. 1 was equipped prior to the year 1924 with seven reciprocating steam pumping engines having an aggregate capacity, against heads of from 120 to 190 feet, of 162,000,000 gallons per 24 hours; Station No. 2 is now equipped with six reciprocating pumping engines having an aggregate capacity, against a 190 ft. head, of 201,000,000 gallons per 24 hours. These pumps deliver water to three distinct distribution systems against the following pressures: high, 75 pounds per square inch; intermediate, 65 pounds per square inch; low, 50 pounds per square inch.

In 1925 the demand for water had become so great that steps had to be taken to increase the pumping capacity to forestall a water shortage. It was decided to remove two of the steam pumping engines of 24,000,000 gallons per 24 hours, capacity of each, in Station No. 1, and to replace them with electric-motor driven centrifugal pumps.

Two Additional Units

In October, 1925, contracts for the centrifugal pumping units were entered into with the Worthington Pump and Machinery Corporation, New York. This contract called for two 36-inch centrifugal pumps for direct-connected electric motors and all auxiliary equipment such as switchboard equipment, control apparatus and pump priming arrangements to be installed by the contractor on foundations provided by the city.

As the city was facing a water shortage condition, the time available between the letting of the contract and its completion was short, especially so in view of the fact that a number of unusual problems had to be met. It was specified that one of the pumps be able to deliver 50 million gallons of water per 24 hours, and the other 70 million gallons, each against 170 foot head. The casings for both pumps were to be the same and the pumps so designed that the one of smaller capacity could be converted at some later date to have a capacity of 70 m. g. d. with no change except the impeller. In addition to this unusual condition to be met, high efficiency was required for both units.

An overall efficiency of the combined electric motor and centrifugal pump of 80 per cent was required for each of the two units. A bonus was offered for each additional per cent efficiency over 80 per cent, up to a maximum of 85 per cent. At the same time a penalty was imposed for each per cent below 80 per cent, with an option on the part of the city to reject the units if the overall efficiency did not exceed 78 per cent.

Since the city was facing a water shortage condition, it was important that the pumps be in service at a specified time and that no alterations or adjustments be required.

The City of Detroit selected the double-suction volute type of pump with horizontal shaft. The Worthington Pump and Machinery Corporation decided that the most satisfactory way of developing the details of the design for these pumps would be through the adoption of the "model" system already well established in the engineering of hydraulic turbines.

New Pump Designed

In this way Worthington planned to secure high efficiency and to accomplish the production of a wholly new design of pump in the minimum length of time. It was considered a certainty that the tests of the model pump would predetermine the characteristics of full-sized pumps and that full-sized pumps could be put into service, immediately after erection without changes or alterations.

Designs for the full-sized pumps were immediately prepared on the basis of established experience. Simultaneously two 10-inch geometrical model pumps similar hydraulically to the full-sized pumps were designed and placed in immediate production.

Two model casings differing slightly from each other and two model impellers, likewise differing slightly from each other, were constructed and tested. From the tests of these models, two conclusions were drawn. One involved the modification of some of the details of the full-sized pump, the main parts of which

(Continued on Page 56)

WATERPROOF and CURE

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THE "HUNT PROCESS" is the modern method, eliminating all the disagreeable features connected with the curing of concrete pavement, concrete pipes of all sizes; concrete piling; concrete reservoirs and all classes of gunited structures.

THOROUGH WATERPROOFING is accomplished by the application of one coat of "McEVERLAST" Concrete Cover Coat to any material which has been cured by the "HUNT PROCESS." Severe tests have shown that this product will withstand water and dampness better than anything else on the market, and that it is highly resistant to alkali, gas, acid and salt water.

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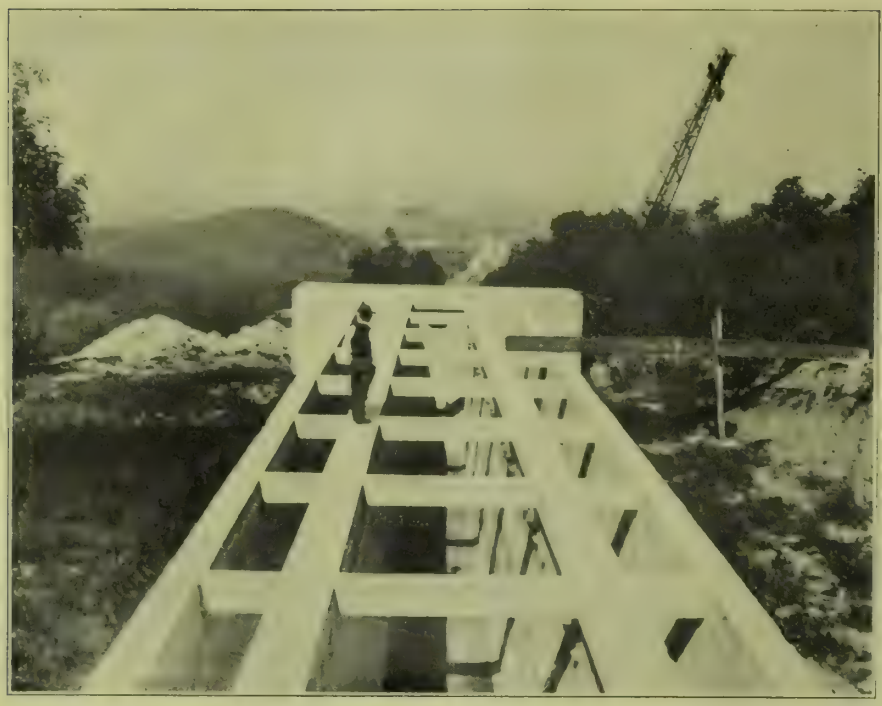
For Detailed Listings See the Western Buyers' Guide of Waterworks Equipment—Pages 75-76



One of the large aeration chambers being installed upon the aqueduct pipe line.

East Bay Aqueduct Being Rushed to Completion as Emergency Measure

(*Continued from Page 35*)

about 83 miles, is built of steel and may be operated by gravity or by gravity flow combined with a booster pump at the Walnut, Creek Pumping Plant. When operated by gravity, the pipe will deliver about 31,000,000 gallons of water daily, at Walnut Creek Tunnel, when the surface of the reservoir is at 520 feet above sea level. The capacity will increase with the rise of water in the Pardee Reservoir, and when it is full the pipe will deliver about 37,000,000 gallons daily. By operation of a booster pump at Walnut Creek, this capacity will be increased to about 60,000,000 gallons daily.

The pipe line is protected from collapse which might result from a vacuum due to breaking of pipe and the consequent rush of water to the break, by the installation of vacuum relief valves at numerous points where the slope changes, usually at summits. These valves will allow air to enter the pipes and relieve any vacuum produced. As a protection against damage to neighboring property from breakage in the pipe four 24-inch automatic synchronous stop and relief valves have been placed at points where no damage would result from discharge of water. These valves are so adjusted as to open whenever a material increase in the velocity of water occurs, allowing the water to flow out from four places, thus reducing the quantity discharged at any one place and preventing discharge at the point of the break.

The pipe line varies in diameter from 61 to 65 inches and is made in 30-foot sections, with longitudinal seams welded by electrical arc. The thickness of the steel is ½ inch throughout most of its length, but a portion at the eastern end is 7/16 inch, and a portion near the western end is 7/16 inch, while still another portion is ⅜ inch in thickness.

As the pipe passes under three branches of the San Joaquin River, its elevation is below sea level, and the maximum water surface of the reservoir is 570 feet above sea level.

The welding of pipe of this size and thickness by electrical methods was somewhat experimental, but it has been made an entire success. All sections of the pipe are tested to a pressure of 50 per cent above the ordinary working stress before being placed.

Several methods of joining the sections of pipe in the field were tried, and the one finally adopted as being the most satisfactory and economical is to join the sections by riveting.

The pipe is buried throughout the greater part of its length, but for a distance of 11 miles where it parallels the Santa Fe Railroad, it is supported above the ground on pile benches at intervals of 30 feet, owing to the difficulties of construction and repairing throughout this region. On this particular portion of the line all joints are double riveted.

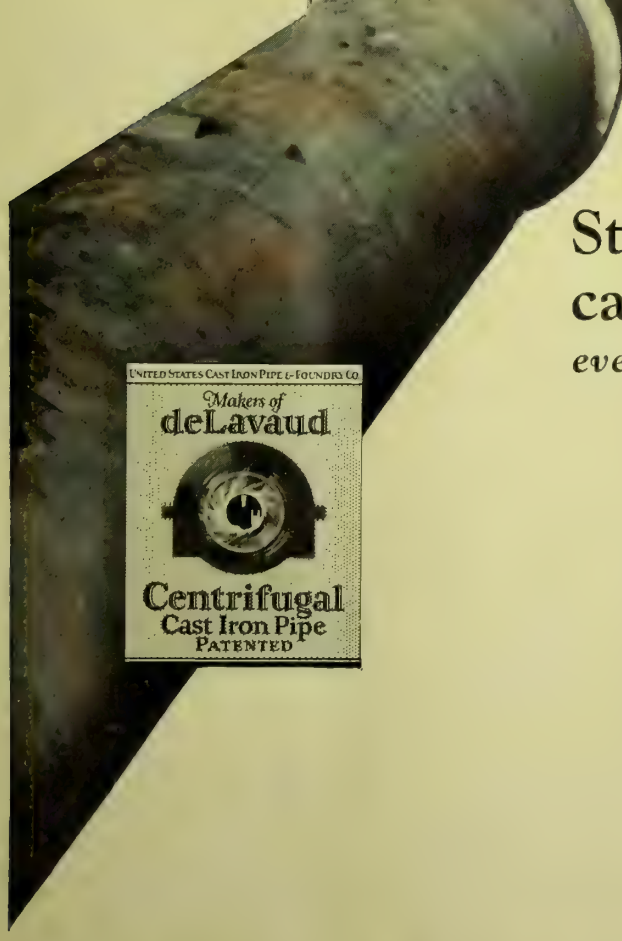
Water will enter the district at the Claremont Tunnel at an elevation of about 330 feet above the sea level. The district is long and narrow, tending in a general northwesterly and southeasterly direction between and including Richmond on the north and San Leandro on the south,—a total length of about 20 miles. The Claremont Tunnel enters the district a little north of the center, and considerably north of the center of population and water consumption.

Balancing Reservoirs on Line

To carry water to the consumers with least loss of head, and to furnish good fire protection for the entire district, three main distributary aqueducts are planned; one extending for about ten

A view of the sixty-five-inch pipe in the trench.

PHOTOGRAPH showing part of a cast iron pipe installation at Chicago, Illinois.



Standard Bell and Spigot can be laid easily ~ ~

even under the most unusual conditions

THE cast iron pipe illustrated here passes through an *unlined* rock tunnel.

The strength of Cast Iron Pipe makes this type of installation possible. The accessibility of lines laid in this manner will be quickly appreciated by engineers.

Contractors have long been aware of the ease of standard Cast Iron Pipe installations and can make their bids accordingly.

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For Detailed Listings See the Western Buyers' Guide of Waterworks Equipment—Pages 75-76

Piping materials to meet all waterworks demands

Representative of the complete Crane line for waterworks are Crane iron and ferrosteel wedge gate and double disc gate valves, brass wedge gate and double disc gate valves, indicator posts, and welded steel pipe with dipped and wrapped coating.

These and all Crane valves and piping are rated to allow ample margin for expansion and contraction and water hammer. All possess the unfailing safety and dependability upon which the 72-year Crane reputation has been built.

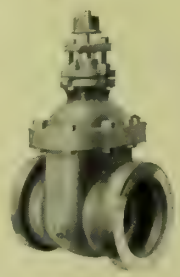
For piping materials for any waterworks purpose, consult the nearest Crane branch.

No. 438 brass wedge gate valve, screwed end.

No. 440 brass double disc gate valve, screwed end.

No. 461 iron wedge gate valve, flanged end.

No. 462 iron wedge gate valve, hub end



No. 480½ iron double disc gate valve, hub end.

No. 520 indicator post.

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miles to the southeast, and one extending for a similar distance to the northwest. Each of these will have several large branches. Each will terminate in a balancing reservoir which is slightly lower than the discharge of the Claremont Tunnel, which will receive the water of the proposed aqueducts whenever it is not all consumed along the way. In case of a break of some aqueduct, one portion of the district served will continue to receive water from the aqueduct while the other will draw from the terminal reservoir, so there will be no discontinuance of water service. A third aqueduct will extend southwestward from the Claremont Tunnel to connections with large pipes in the heart of the city.

The plans for these connecting aqueducts are not yet quite completed, but they will be pushed to completion and placed in construction within a few months.

The main aqueduct from the mountains to the discharge end of the Claremont Tunnel is under contract for completion in February, 1929, and it is anticipated that it will be completed by that time.

Owing to delay in securing rights of way and flowage rights for the Pardee Reservoir and outlet tunnel near Valley Springs, these units have only recently been placed under construction, but it is hoped that the outlet tunnel can be completed within two years, and that the reservoir dam will be completed to a height which will divert water in 1929, and that thereafter water can be delivered from the mountains into the district.

Re-Inforced Concrete Pipe for Sewage Disposal Lines

Enormous Projects Now Under Construction of Being Contemplated Use New Type Concrete Pipe.

The problem of adequate and sanitary sewage disposal is fast coming to be a vital consideration in the growth of many of our cities and towns. As each city pushes out toward its neighbor, and each tends to solve its own sewerage problems to the detriment of the other, difficulties necessarily arise.

A certain number of Southern California cities have relieved their situation by forming districts and building a general system of collecting and outfall sewers that ultimately discharge into the ocean. One of these systems now approximately half completed, serves the cities of Compton, Huntington Park, Inglewood, Torrance, Clearwater and

(*Continued on Page 77*)

1,200,000 Gallon Water Tank for City of San Diego, Protected with Hill, Hubbell & Co. Biturine Products.

SAN DIEGO *California* BUYS CORROSION INSURANCE

Problem of Water Tank Protection Solved by BITURINE ENAMEL

Engineers for the city of San Diego, in erecting one of the largest elevated water tanks ever built, wisely provided for rust and corrosion insurance by specifying Biturine Enamel—the **permanent** corrosion preventive.

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NEW YORK CITY
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SEWAGE DISPOSAL

Site of temporary treatment plant. Note how it is shielded from view by Eucalyptus trees.

Semi-Elliptical Outfall Sewer of Novel Design Being Built by L. A. County

Interior Lining of Clay Tile with Sulphur Compound Between Joints Protects Concrete from Septic Acids

By A. K. WARREN
Chief Engineer, L. A. County Sanitation Districts

THE general plan for sewering the southern portion of Los Angeles County has been heretofore described in the January, 1927, issue of Western Waterworks in an article by the chief engineer of the Sanitation Districts, in which the system of main and tributary trunks conveying sewage from the communities in Los Angeles County to the ocean at White Point was outlined and stating in general the aims and activities in the project up to that time.

Subsequently in April, 1927, an article describing the plans for a temporary activated sludge plant for use by the Districts was described by the Assistant Chief Engineer, in which it was mentioned that the action of the State Board of Health of April 2nd, 1927, granting permission to the Sanitation Districts to discharge settled sewage effluent at White Point might influence the Sanitation Districts to complete a larger portion of the joint trunk outfall and locate the temporary plant farther south along the general line of the trunk system at the site selected for the permanent sedimentation plant of the completed system.

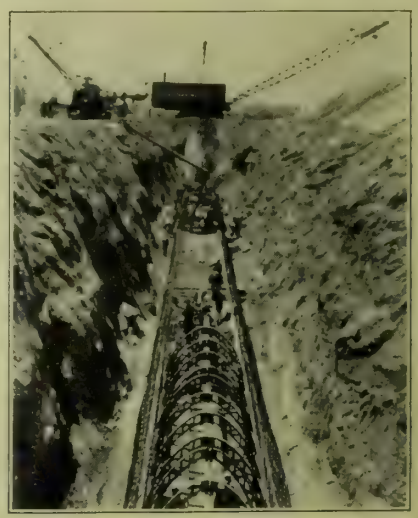
This conjecture has become a fact and the Districts are now constructing an activated sludge plant of the same type and general characteristics as that heretofore described on the Districts' Sedimentation Plant site north and east of Harbor City. Work of construction in this feature will be completed in January, 1928.

Emergency Plant Under Construction

The plant being constructed is for the use of such portions of the Districts as are in immediate need of sewerage facilities and is being constructed of such size and capacity as to accommodate the anticipated sewage flow from such areas until negotiations now pending with the cities of Los Angeles and Long Beach are brought to settlement permitting the joint construction of an outfall line from the plant site to the ocean at White Point as a joint undertaking by the Districts and the City of Los Angeles. It is anticipated that the temporary plant will be in operation for a period of about two years.

Plans for the activated sludge plant are nearly identical with those formerly prepared for a similar plant to be located on the Nigger Slough Drainage Channel for the use of Districts Nos. 1 and 2. Few, if any, material changes have been made excepting that the present plant is more susceptible to enlargement and expansion than that formerly contemplated. It will serve District No. 5 in addition to Districts Nos. 1 and 2. It is located on District ground within the borders of Sanitation District No. 8 about two miles north and east of Harbor City, which is a portion of the City of Los Angeles.

By April of 1927, at which time it was proposed to build a temporary treatment plant for the use of Districts Nos. 1 and 2 at Nigger Slough, the construction work on the interior trunks of Districts Nos. 1, 2 and 5 was about 50 per cent complete, but little work had been done on the joint outfall itself. At the present writing all of the joint outfall leading from District No. 2 to the present treatment plant site is constructed or under construction, excepting for a small section leading to the easterly area in District No. 2. The main trunk from District No. 5 area is completed



Invert in place—pouring invert arch forms 9'-6" semi-elliptical.

or under construction to Torrance and the portion leading from Torrance to the treatment plant site has been ordered and will be advertised for construction within the month.

Protective Linings

The distance from the lower reaches of the trunk system and the joint out-

(Continued on Page 58)

Reflecting pool between the Lincoln Memorial and Washington Monument, South Potomac Park, Washington, D. C. For U. S. War Dept.

The entire bottom and sides of this pool, involving an area of about 9 acres were waterproofed with KARNAK MATERIALS.

KARNAK MATERIALS represent in quality and uniformity the highest point to which waterproofing engineering has yet been carried. This superiority manifests itself in:—

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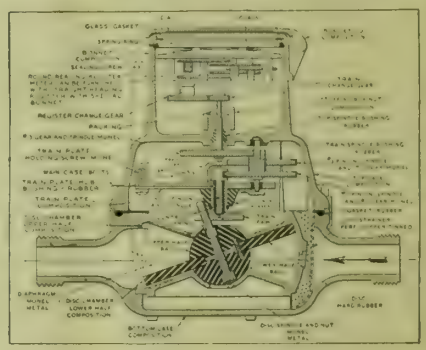
Interesting Exhibit Planned by Meter Manufacturer

Cut Open Models of Bronze Meter Will Be Displayed by Worthington Pump and Machinery Company

An unusually attractive convention exhibit has been prepared by the Worthington Pump & Machinery Company, according to Arthur Crooke, Pacific Coast manager of the meter department. In connection with the line of meters they will have on exhibit, the company has prepared a booklet to be distributed from the convention booth. This is entitled "A Trip through the Worthington Meter Factory," and describes in detail how the meters are made.

The exhibit of the Worthington Company will show cut-open models of the more popular types of instruments, particularly those which are being widely used in various California cities. Among these is the new model "G," with both



Section of Worthington Model "G" Water Meter

inlet and outlet spuds threaded and with oval flanged connections. This is the first showing of this latter type of meter.

The model "G" meter is made of especially selected bronze which has been heat treated by electric furnaces for the purpose for which it is used. Some of these meter castings are a combination of intricate design and small section, so that they require a very hot metal for casting. The electric furnace, with its ease of temperature control, is especially adapted to this class of work, as the metal can be properly heated without danger of being oxidized. Castings made from oxidized metals are not so sound and are more susceptible to corrosion. All castings for Worthington meters are made in Detroit Electric furnaces, and after being cast are triple inspected for flaws and possible oxidation. If any such defects are found the casting is discarded and that piece of metal never again used for any portion of meter construction.

For Detailed Listings See the Western Buyers' Guide of Waterworks Equipment—Pages 75-76

The showing of the model "G" meter with cast-on flanges is the first that has been made in the West. These instruments are now being made with a two bolt oval flange, the over-all dimensions of these flanges being standard with two or three other makes of meters. The great advantage of this can be readily seen.

The train gears of this instrument are made from nature's natural alloy, monel metal, instead of bronze composition, because this former metal is absolutely not subject to the corrosive action of any water found along the Pacific Coast. A double protection is afforded by running these gears in grease, which also resists corrosive action of any kind.

With the exception of the monel metal train gears, all parts of Worthington meters are made of especially selected bronze, even to the main case bolts. Certain specifications demand that all water meters be tinned inside and out, and the company builds such an instrument to meet these specifications. The standard, however, is the entire bronze construction in natural finish.

The disk spindle, diaphragm, interior screws and moving parts of the intermediate train gears are made of monel metal, which is non-corrosive. The parts of this intermediate gear system are identical in all size meters, so that they are readily interchangeable. This is a very desirable feature as it enables the customer to carry a minimum of repair parts for all size meters.

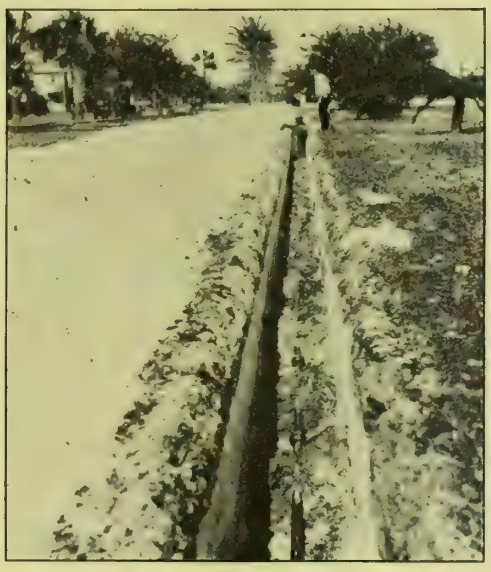
Non-Clogging Sewage Pump

The Buffalo Steam Pump Co., with offices at Los Angeles, Calif., has developed a new non-clogging raw sewage pump which is absolutely guaranteed to handle any material that will pass the eye of the impeller. The largest will handle solids up to 10-in. diameter and has a capacity of 4800 gallons per minute. This pump will take care of rags, strings, sticks and solids of all kinds. Extensive tests and actual use have demonstrated that the pump will not clog.

The impeller is enclosed and has free passages throughout, with no projecting surfaces to obstruct the flow of solids or foreign material. Quick opening clean out doors are provided—in the casing and in the suction box on vertical pumps, and in the suction elbow on horizontal pumps. Special vertical guide bearing and ball type thrust bearings are furnished with the vertical type pumps. These bearings are non-overflowing and will not throw oil.

The construction is ordinarily of cast iron, but bronze or other special composition metals can be used where the service requires.

Flameless Fire



1¼-inch McWane Precalked Joint
CAST IRON PIPE

RUST—"flameless fire"—consumes over one billion dollars worth of steel every year. Much of this is water pipe. Once you could not help yourself—the everlasting cast iron pipe was not made smaller than 4 inches.

Now you can get cast iron pipe as small as 1¼ and 2 inches. And equipped with the genuine McWane Precalked lead joints, which makes laying swift and simple.

Cast iron pipe costs less *per year* than pipe made of any other material. At least investigate before you buy another foot of perishable pipe.

We also make larger sizes—3, 4, 6, and 8 inches. Standard lengths. Either with or without the Precalked Joints. Send us your inquiries. Ask for catalog and booklet.

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METERS & METERING

Meter Service Lines to Curb Installed Prior to Making House Connections

Newly Standardized System Avoids Unnecessary Disturbance of Pavement and Reduces Ultimate Cost to Consumer

By GEORGE W. READ*

AT this time all domestic water connections in new subdivisions are being installed by laying a pipe from the main to just inside of the curb, about two feet from the dividing line of two lots. This location has been fixed to allow poles to be set on the dividing line of two lots.

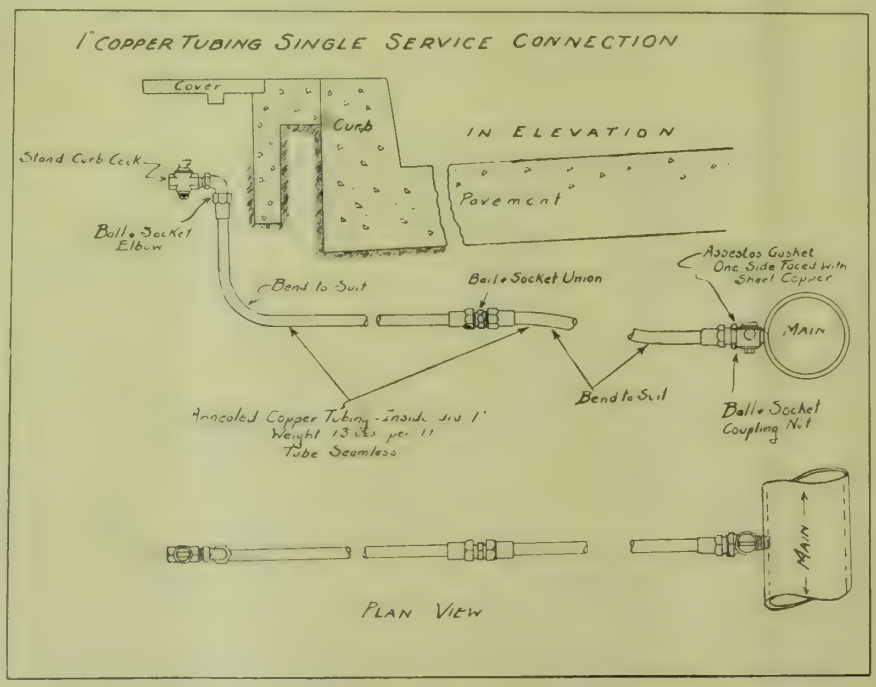
Kind of Pipe

Two-inch cast iron pipe is generally used, on account of its long life, each connection supplying two or three consumers. The district and type of consumers determine whether two or three connections will be made. In filled ground where settling is liable to occur, extra-heavy, asphaltum-dipped steel pipe is used; on hillsides where the pressure is heavy, extra heavy, 1½-inch, asphaltum-dipped steel pipe is sometimes used for the supply of two services.

Extra heavy steel pipe or copper tubing is being used for the installation of ¾ and 1-inch single services scattered throughout the city. Red brass pipe, of half-inch iron pipe size, is being used for services to supply flush-tanks.

The two-inch cast iron pipe is ¼-inch thick and weighs about 6 pounds per lineal foot, and has been tested to 1000 pounds per square inch. The 1½-inch extra heavy steel pipe weighs 3.63 pounds per foot, and the 2-inch weighs slightly over 5 pounds per foot.

On cast-iron water mains up to 10-inch size, a cast-iron saddle is strapped to the main, and on 12-inch mains and up a bronze saddle is used. On sheet-steel mains a heavy coupling is electric- or acetylene-welded to the main, and takes the place of a saddle. On standard screw-pipe a bronze saddle is used, and if under heavy pressure, a coupling is electrically- or acetylene-welded to the main.



Sketch of Standard 1-Inch Copper Tubing Service Connections Used by Los Angeles.

Water Main Connections

Into the saddle or coupling a 2-inch or 1½-inch special corporation cock is screwed. The 2-inch size is equipped with a 2½-inch iron-pipe thread for screwing into the clamp or coupling, and the outlet end is equipped with a bell for a lead joint; it also has a 4-inch standard iron-pipe thread for holding the tapping machine. This thread is also used for connecting the 2-inch screw pipe to the corporation-cock.

The 1½-inch corporation-cock is equipped with a 2-inch standard iron-pipe thread for screwing into the clamp or coupling; the outlet is equipped with a bell for a lead joint, and it also has a 3-inch standard iron-pipe thread for tapping purposes; this thread is also used for connecting the 1½-inch screw pipe to the corporation-cock.

Half-inch, ¾-inch and 1-inch corporation-cocks are inserted into the main or clamp for single-service installations; lead goose-necks are no longer being used. The corporation coupling-nut tail-piece formerly used for lead flanging now has a female thread for connecting to the corporation-cock by a ground joint.

Services larger than two inches are taken from the main either by clamping, or by welding on a heavy coupling. A tapping-nipple is leaded into the clamp, or screwed into the coupling; on the other end of the tapping-nipple is placed a gate, through which the main is tapped. Tapping-machines for sizes from 1½-inch up to 8-inch are made by our department.

Two-inch cast iron pipe in five-foot lengths, with leaded joints, is run to a point within the curb. Some of the five-foot lengths are made with a bead on each end, and double beads 7½ inches apart along the pipe. When cutting is necessary to make the required length of the service, the cut is made between the double beads, thus providing a bead at each lead joint to prevent blow-offs.

The five-foot length that ends just inside the curb is equipped with a 2-inch standard iron-pipe thread on which an elbow is screwed. Into this elbow is screwed a piece of extra heavy steel pipe about 20 inches long, equipped with a tee for the supply of two services, or a cross for the supply of three services.

*Superintendent of Meter and Service Department, Los Angeles Bureau of Water and Supply

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"A trip through the Worthington Meter Factory"

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It takes the reader through our meter department at Harrison, N. J., giving him a glimpse of many of the processes involved in the manufacture of high-grade meters.

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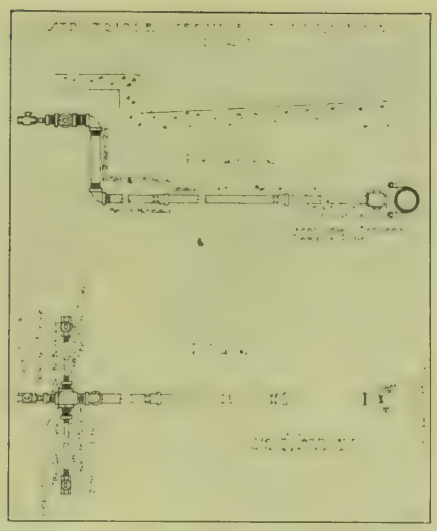
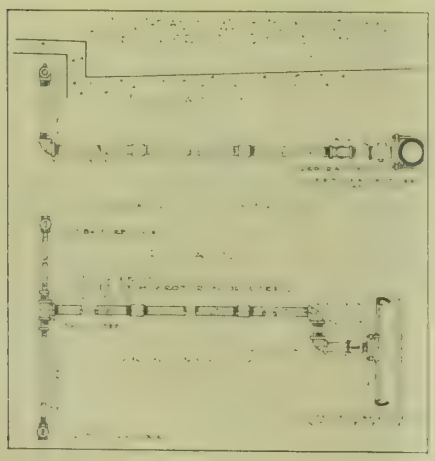


Standard Triple Service Connection Using Cast Iron.

This tee or cross is equipped with bronze bushings reduced to the size of the service required at the date of installation. Where two outlets occur they may ultimately be enlarged to supply two 1½-inch services; where three outlets occur they may ultimately be enlarged to supply three 1-inch services; without cutting into the paved street.

When we are not sure of the location of driveways, a 10-foot piece of extra-heavy steel pipe, equipped with a curb cock on the end, is run both ways from the tee on the riser.

Curb cocks on services that are not immediately put into service are sealed, and can be used for flushing purposes. Galvanized iron or steel services already installed in streets that are to be permanently paved, are being renewed with cast-iron, etc., as already stated.



Extra heavy wrought iron and steel double service connection.

When tapping large trunk lines, the feed-pipe just inside the curb is equipped with a curb cock according to the size of the feed-pipe to be used when enlarging a service and other mains are shut off for a few minutes while making enlargements.

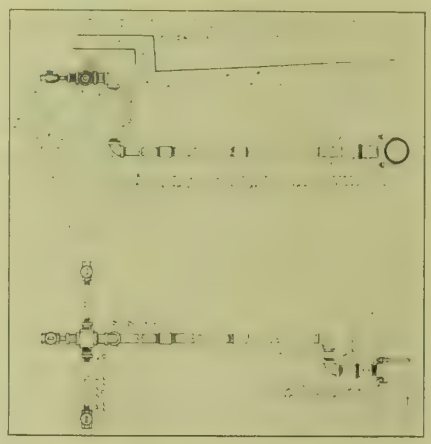
Fire Services

Cast iron pipe is used mostly for the installation of fire services, and when possible, the domestic supply is taken from the fire service just inside of the curb. A tee is placed on the fire line for the domestic supply, and bushed down to meet the size of the domestic service. If the size of the domestic service is required to be enlarged, the bushing can be removed and the service enlarged without digging in the street.

Service Installation Before Paving

Public sentiment is in favor of all utilities being installed in advance of street paving, and this is becoming more and more necessary as paving is being made heavier and heavier to bear the heavy traffic.

In order to meet this demand all vacant lots fronting streets that are to be paved are now being supplied with services under the 1911 Improvement Act.



Standard Triple service connection.

NOTE: The foregoing method of service-installation that is being pursued means good supply to the curb; it practically eliminates cutting into the paving for the enlarging of services for domestic use, and it means low maintenance-cost, due to the long life of cast-iron pipe. Its construction is identically the same as that of standard cast-iron water mains, and it means about one-half the cost to the consumer when enlarging a service.

Snohomish Pumps Ready

Snohomish, Washington, has just completed the installation of a new pumping plant which will supply, if necessary, 1,500,000 gallons per day. This when added to the 1,300,000-gallon supply coming through the gravity line gives a total of a thousand gallons per day for each of the approximately 3000 inhabitants of Snohomish.

Pumping Plants of the Mokelumne River Project

(*Continued from Page 31*)

ed on a single bedplate, connected by a flexible coupling to and driven by a 1,600 horsepower synchronous motor furnished by the Westinghouse Electric & Manufacturing Co. The outlet of one pump is connected to the inlet of the second pump making a unit of two stages capable of delivering 25,000,000 gallons per day against 285 feet head, the pumps being designed for these conditions. The electric motors operate at 600 r. p. m. using 2,300 volt, 3 phase, 60 cycle current. The pumps are furnished with external water seal ring lubrication to prevent seizure of the rings in the event pumps are started while dry.

Equipment Thoroughly Tested

Prior to shipment and following the rigid shop inspection and hydrostatic tests, the pumps were subjected to a series of efficiency tests in accordance with requirements of the district contract, all conditions approximating those of field operation as far as possible in a laboratory test. These tests were made by Pelton engineers in co-operation with engineers of the East Bay Municipal Utility District and every precaution was taken to insure not only operating conditions closely following those to be encountered in actual operation, but absolute accuracy of power, head and water measurements. All of the instruments, gauges and other equipment used were carefully calibrated before and after each run and each reading of an instrument during the test was checked by an independent observer. As a result of the tests it was found that efficiencies obtained from the pumps were considerably in excess of the guarantees made by the Pelton company.

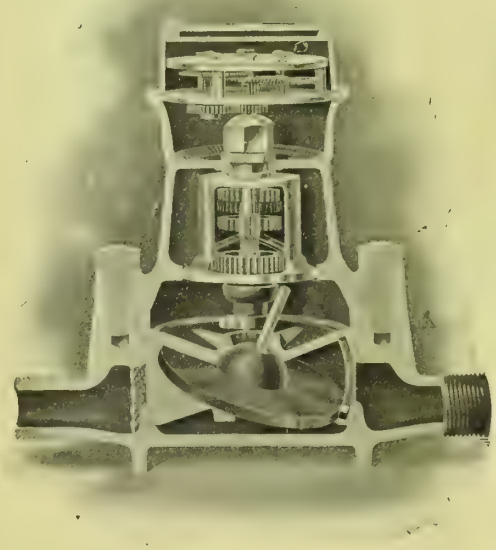
Walnut Creek Station

The Walnut Creek pumping station includes in its equipment in addition to the pumping units and motors, hand-operated gate valves and check and throttle valves, these also being designed and built by The Pelton Water Wheel Co. The latter valves are of the Johnson type, one being installed at the discharge end of each pumping unit adjacent to a main stop gate valve. As the check valve implies by its name, any reversal of flow in the pipeline in the discharge side of the pumping units will build up pressure in the valve body, causing the plunger to move to its closed position and thus check any reverse flow which may occur from any cause whatsoever. The closing movement is regulated in the design of the valve so that

(*Continued on Page 83*)

Neptune Trident

"The Cash Registers of the Water Works Field"



VOLUMES have been written on the subject of municipal waterworks operation and increased revenue production. But the last word is said with the installation of Trident Water Meters. For in these accurate meters has always FIRST appeared every worth-while improvement in water measuring mechanism. Of TRIDENT and Lambert Meters, over 4,500,000 have been made and sold the world over.

The eight outstanding pioneering developments in water meter design were all TRIDENT. Write for Catalog giving full particulars.

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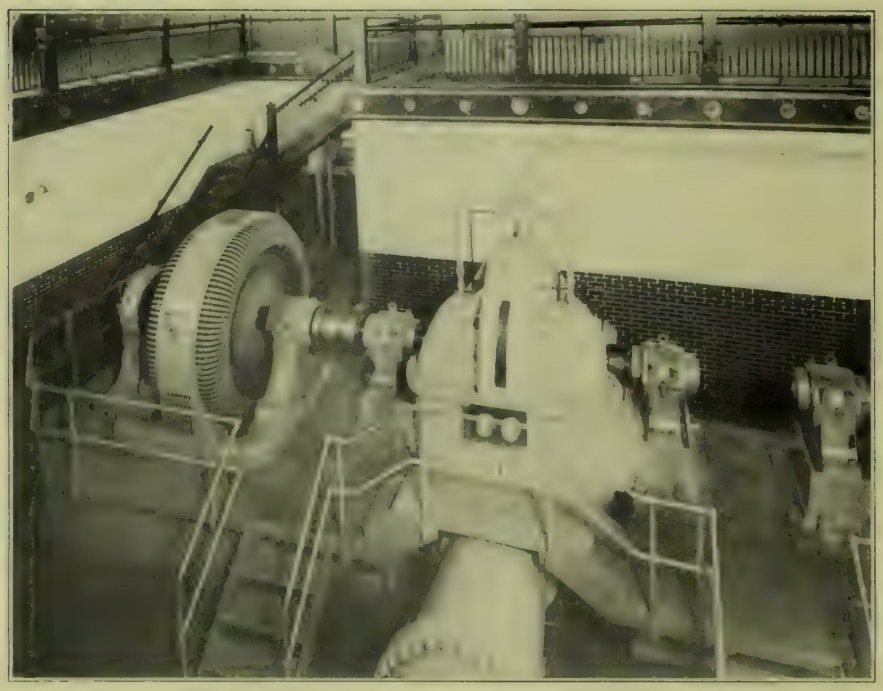
For Detailed Listings See the Western Buyers' Guide of Waterworks Equipment—Pages 75-76



A close-up view of a 50 M.G.D. motor-driven Centrifugal Pumping Unit installed in the City of Detroit Water Works. The overall efficiency of this unit (pump and motor) is 84.7 per cent.

Large Waterworks Installations Use Motor Driven Direct Connected Centrifugal Pumps

(Continued from Page 42)

were in production. The other conclusion was a predetermination of the characteristics of the full-size pumps.

The final units were tested, after installation at Detroit, in January, 1927, by Mr. William C. Rudd, Assistant Engineer of Power, Department of Water Supply, City of Detroit, with all parties concerned present.

The results of these tests are shown by the two sets of characteristic curves for the 50 m. g. d. and the 70 m. g. d. units respectively. It will be noticed that the 50 m. g. d. unit showed a maximum efficiency of pump and motor combined of 84.7 per cent and a pump efficiency, based on test of the driving motor, of 88.5 per cent under the contract capacity rate at a head of 170 feet. This is a world's record. The 70 m. g. d. unit showed a maximum combined efficiency of 82.7 per cent and a pump efficiency, based on test of the driving motor, of 86 per cent, which is remarkably high considering the fact that it was required that both pumps have the same casing.

The motors for driving the pumps are General Electric synchronous motors with direct-connected exciters, the motors running at 514 r. p. m. The full load rating of the motor for the 50 m. g. d. pump is 2050 hp. while that of the motor for the 70 m. g. d. pump is 2600 hp. The 70 m. g.d. pumping unit is the largest motor-driven waterworks pump with respect to horsepower installed to date.

Among the other great advantages of the model construction and test procedure, was the elimination of shop tests of the main units, except of course, hydrostatic and balancing tests. It was thus possible to meet contract conditions as to special design, high efficiency and short delivery with positive assurance as to the performance of the main units. The significance of this fact will be especially appreciated if it is remembered that test conditions for the model pumps could be closely regulated, while in the full-size pumps, conditions of operation during a shop test, without exception, vary from those required even when excellent laboratory facilities are available.

The high efficiency of the type of the model pump as well as the 50 m. g. d. and 70 m. g. d. pumps installed at Detroit Waterworks has again been established by the field tests on two 20 m. g. d. synchronous motor-driven units installed in the new waterworks of the City of Dayton, Ohio. These two pumps were designed for a capacity of 20 m. g. d. against 185 feet total dynamic designed for a capacity of 20 m. g. d. against 185 feet total dynamic head. On field tests they gave a slight over-capacity and a maximum overall efficiency (pump and motor) of 84 per cent.

Chlorinating San Francisco's Water Supplies

(Continued from Page 37)

pounds. From the injector the solution is fed through a special armor rubber hose to the suction of the pump, which in passing through gives a perfect mixture. Provisions have been made for feeding the solution into the discharge line if for any reason the pump is shut down.

Injection System

Water for the operation of the injector is taken from the discharge line of the turbine pump at a pressure varying between 140 and 145 pounds. As this pump is only operated for periods during the year, it was necessary to install a small triplex pump to maintain the required pressure during the intervals while the large unit is down.

The temperature of the building is kept up by means of an electric heater.

The instruments are cleaned thoroughly every three months, but in addition to cleaning very little attention has been necessary.

The stations do not require special attendants. The engineers and operators at the pumping stations and the lake watchmen at the weirs have just taken this care over as another duty during their regular hours of work.

With this in mind, the simplicity of the station for easy operation was considered during the installation of the chlorine system.

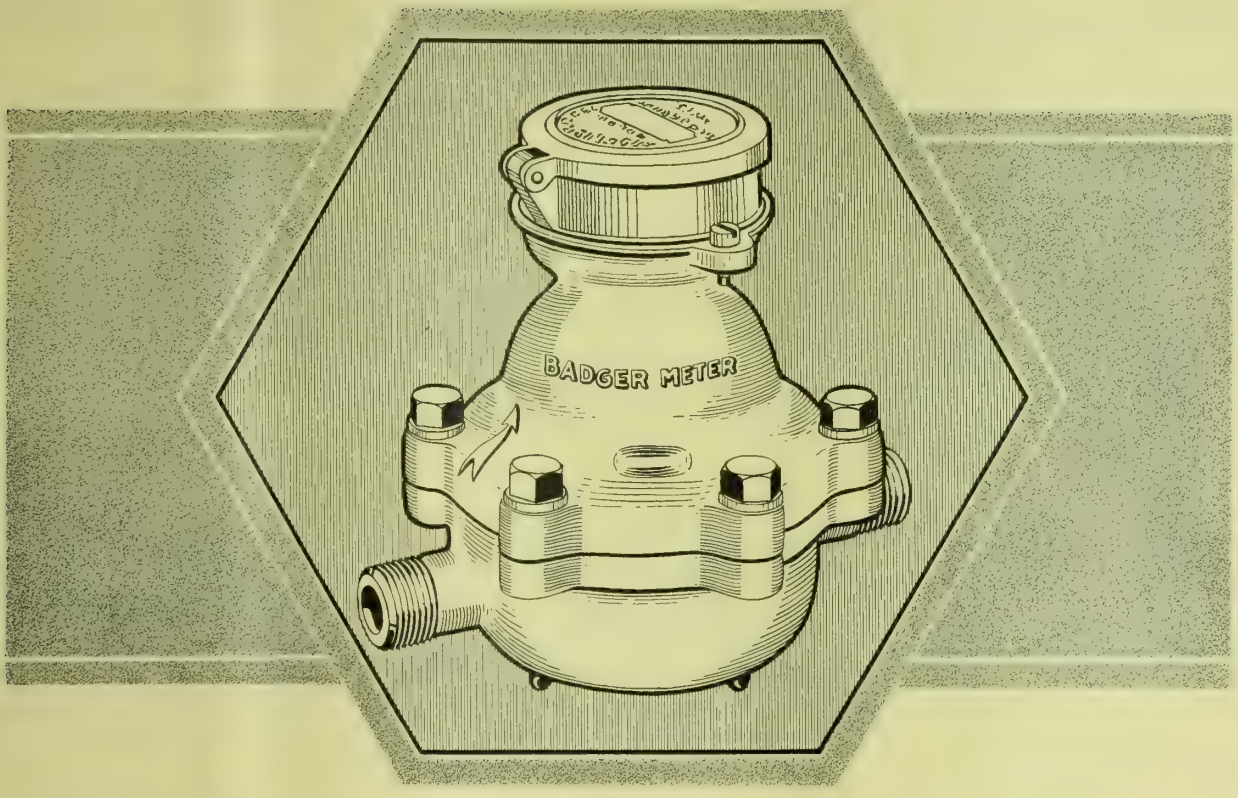
System of Records

A duplicate report book is kept at all stations for observations of conditions on each visit of the operator, giving the existing pressures, weight of tanks, condition of water, residual chlorine, etc. The original copy is sent to the office for record.

Operators are kept posted as to the results of the laboratory tests and of any reports of their stations from outside sources to create and keep up interest in their part of the work.

Water is supplied by the company to the suburban towns through which the pipes pass and as a result of installing the chlorinating plants at the source of supply, all are reaping the benefit of the treatment.

C. F. Keefe, manager of the line pipe department of the American Seamless Tube Corporation, expects to make an extended visit in northern California after attending the convention of the California Section of the A.W.W.A. at San Jose.



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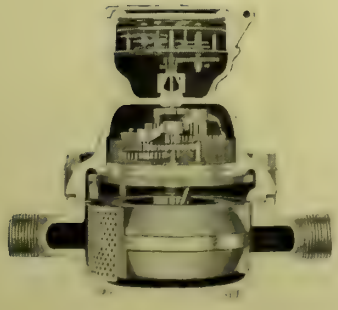

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BADGER Water METERS

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Invert arch forms and liners placed. Applying sand, sulphur compound.

Semi-Elliptical Sewer Pipe With Tile Lining Being Used by L. A. Sanitation Districts.

(Continued from Page 48)

fall to the tributary cities and communities in the northerly areas of the Districts is such that the sewage will undoubtedly be in a septic condition as it flows through the joint trunk itself and for this reason extraordinary precaution has been taken to protect the inner faces of the large dimension reinforced concrete sewers from the destructive gases emanating from septic sewage. For the purpose of protecting such concrete the Districts are lining the large sewers with vitrified clay tile liners in the manner shown more clearly by the accompanying pictures than by description. Where it is thought that the sewage will have become extremely septic and its destructive qualities thereby enhanced, the joints between such vitrified clay tile liners are being filled with a compound consisting of sand, sulphur and silica.

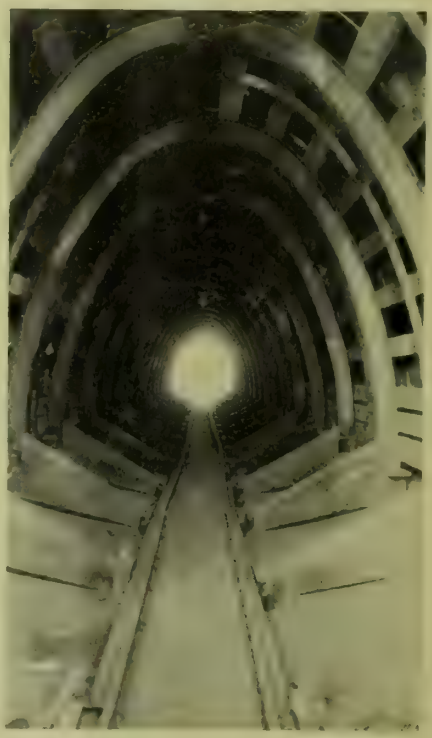
Use of the sand, and silica compound as a joint sealer in connection with the vitrified clay liners is believed to be necessary because of the rapid penetration into, and destruction of, the concrete between liner blocks by the septic sewage gases. The chemical change which apparently takes place in the concrete under the action of the sulphates appears to cause an energetic expansion of the original joint concrete, spalling off the edges of adjacent liners and, it is believed, the process may continue through the joint concrete into the concrete behind the liners, pushing them loose from the arch, thereby thwarting the purpose for which the liners are placed. The sand, sulphur silica compound, as near as can be determined, appears to be inert in the presence of the gases given off by a septic sewage and for this reason is used to seal the cracks between liner blocks.

The compound is applied hot, from a special type of melting and pressure pot equipment; is transported from the pressure pot to the point of application through a steam heated flexible metal hose and applied to the joints, where it crystallizes in place so rapidly as to allow the workmen to walk over the liners in place almost immediately after application.

Completed interior of arch sewer.

The result of this treatment is to present an inner face in the sewer arch completely protected from the destructive agencies in the sewage; practically impervious to moisture, and with resistant qualities so essential in costly construction of this type.

The largest dimension sewer being constructed at this time is the Joint Outfall Trunk from Districts Nos. 1 and 2 to the treatment plant; it is a 9′6″ semi-elliptical reinforced concrete arch section, lined as described on the inner face. From such maximum size the sewer diminishes in size up stream until the upper section of the joint trunk outfall draining the sewage from District No. 2 is 5′4″ semi-elliptical section, built along the same lines as the larger one. District No. 5 participates in no portion of the joint outfall above the treatment plant site.



View of interior forms, 6′-6″ semi-elliptical section.

The entire work as constructed and under construction at the present time, is a part of the final general plan for sewering the Districts, and the structures are all being built for use in the ultimate plan. The joint trunk sections are being built of the size contemplated in the plan for final disposal and the tem-

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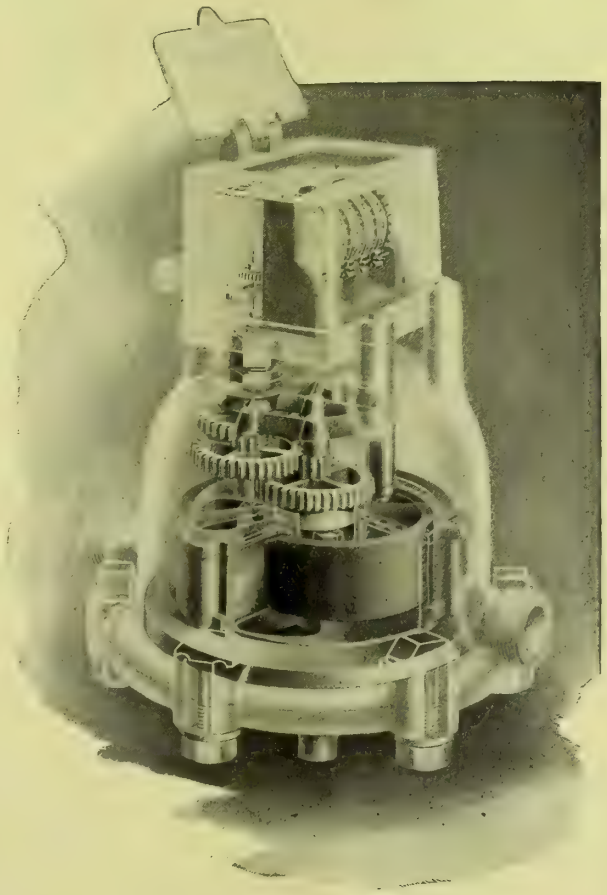
DESIGNS Accuracy, strength and simplicity are the outstanding characteristics of all our designs. New ideas are constantly being investigated, and whenever they prove worth while are promptly adopted.

WORKMANSHIP Only skilled labor of the highest type goes into the making of our meters. They are gauged, tested, fitted and finished with a care that makes them real "instruments of precision."

EXPERIENCE We have been in the meter business since 1870. Many of our workmen, salesmen and officers have been with us from ten to twenty-five years. The knowledge gained in this long period is always at your service.

INFORMATION Any requests for quotations, catalogs, illustrations or special data of any kind will receive immediate attention. Time will be saved by addressing the store nearest you.



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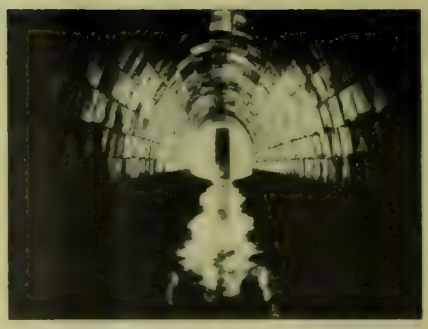


Completed arch section.

porary activated sludge plant is constructed so as to be easily converted into units of a sedimentation plant. To complete the entire plan as originally contemplated by the Districts it will only be necessary to construct additional units to the modified activated sludge plant, enlarging it as a sedimentation plant to the full capacity of all tributary lines and to construct approximately 7 miles large dimension conduit and tunnel to the point of ocean discharge at White Point.

Editor's Note: Units bids upon this type of contsruction will be found on page eighty-seven.

Mannesmann - Pilger Process Pipe for Waterworks Use

American Seamless Tube Corporation Describes New Process Pipe for Water Conveyance

The determination of the most suitable pipe for city water supply and for irrigation projects is of great importance, and should be given the most careful consideration by every consulting engineer. These pipe lines are expected to give the minimum of trouble and have the maximum life.

Irrigation plants and city water services are installed with the expectation that they shall last for generations, and for this reason the very best material obtainable should be used. It would be false economy to save a few dollars in the initial cost of such plants by putting in steel pipes which were too light.

It is obvious that a cheaper, light pipe must have a comparatively short life, and will not successfully resist the attacks of corrosion.

There have been many instances where corporations and municipalities, tempted by the cheaper initial price have put in light pipes. As a light pipe cannot resist rust, it has been found in such cases, that after 4 or 5 years service the whole of the pipe system is in such a corroded state that it had to be taken up and replaced with heavier pipes.

Among the most desirable pipes for water supply and irrigation purposes are

the famous Astco hot rolled seamless steel pipes made by the Mannesmann-Pilger process.

These pipes, which are well known in engineering circles, have gained a world-wide reputation for their rust-resisting qualities. So much so, in fact, that among some they are called "non-corrosive." The splendid qualities of these pipes are due to several reasons.

These tubes are rolled from a solid steel bar without a seam. This rolling process produces a special hard and compact skin on the inner and outer surfaces of the pipes. This hard skin has proven itself to be an excellent protection against the influence of acids.

The steel used in the manufacture of these tubes is of special composition and is very rust-resisting in itself. The steel is very homogeneous and dense in structure. It is clear that steel of such nature offers more resistance against corrosive influences than a more porous metal.

Although the excellent quality of Astco pipes, the special composition, the dense structure of the steel, and the hard skin produced during the rolling process, all give the best possible guarantee of long life—still our mills are not satisfied, but have gone farther, and have adopted a method which makes corrosion practically impossible.

After leaving the Pilger mills, the pipes are reheated and dipped into a bath of especially composed asphaltic solution, so that the solution is burnt into the pipe surfaces. This solution will never crack off, even if the pipes are knocked about or bent.

After this bath, the pipes are wrapped in jute cloth which has been soaked in the same solution. This wrapping is done by a machine especially built for this purpose, and is perfectly adherent and impermeable.

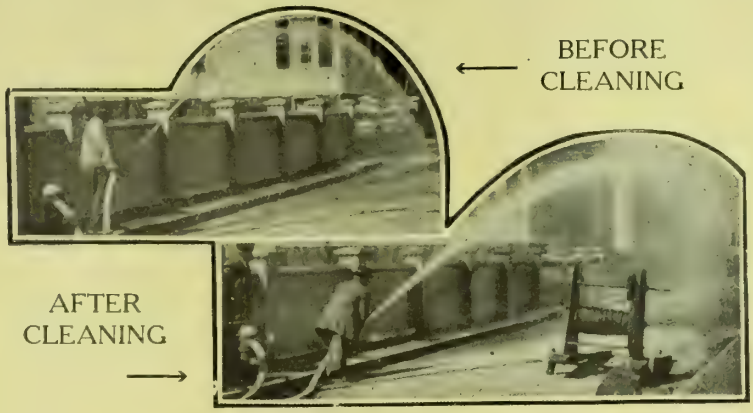
The carbonic acid contained in coal-tar is removed from the solution, so that the preparation itself has no action on the pipe.

That the protection is highly developed is proven by the fact that in the past four decades, during which time Mannesmann process pipes have been laid, not a single instance has been noted where pipes thus protected have been destroyed by external corrosion.

In addition to its long life, it is important that the mains should give no troubles at joints, from bursting pipes, or other defects. Leaking joints or bursted pipes lead to great inconvenience in addition to increasing the cost of maintenance.

It is impossible for Astco pipe to burst. As already explained these pipes are rolled from a solid steel bar, *without*

(*Continued on Page 84*)



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The book gives a comprehensive and well-balanced picture of drainage practice as carried on today. The economic justification of drainage and flood-control projects is set forth clearly. The legal organization of drainage districts, the essentials of drainage law, and the spreading of assessments make up a final valuable chapter.

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WATER PURIFICATION

Scientific Treatment of Water Supplies Simplifies Duties of State Supervisor

Greater Knowledge of Chlorination Methods by Water Operators Assists State Bureau in Decreasing Typhoid

By C. G. GILLESPIE

Chief of Bureau Sanitary Engineering Department, State of California

A NUMBER of considerations have changed both the amount and kind of state supervision over the water supplies of California in the past decade. The tendency has been toward fewer and simpler contacts. One of the first reasons for this situation is that since 1915 nearly all of the stream supplies have been brought under chlorination, thus relieving the need of promotion work and education of operators, who have now passed through the apprenticeship stage in operating chlorine machines where they have heretofore nedeed guidance.

At first operators were just a little unconvinced of the need of a safer water and interest was only halfhearted. Gradually they learned more about the equipment. They began to see the accomplishments as revealed by health reports and analyses of the water. Now it is an exception to find an operator not well informed and interested in the safety of his supply. Over this same period, too, the frequency with which courts have held purveyors of water liable for typhoid contracted from it could not help but make a deep impression, and it has lessened the apparent need of other outside supervision. The second reason for less state contact is that state supervision has had to be scattered over more fields.

Increased Population Adds to Pollution

It is not intended, however, to spread the impression that precautions in rendering the waters safe are growing less important or even that chlorination is fully perfected. As a matter of fact truly dependable chlorination has not been reached in any of our installations and many of the surface supplies, once fairly free of human contact, are now exposed to more and more danger from an increasing population on their watersheds, largely composed of those who hunt or attractive wild spots for pleasure purposes. If anything, the precautions ought to gradually go further than they do now to keep pace with the pollution load.

To digress further in this vein, well waters, as a class, have occupied in all minds a high position for safety. Yet out of eleven outbreaks of typhoid traced to water in California since 1914, involving a total of 660 cases, 380 of the cases occurred in one epidemic and that was a polluted well supply where the sewage backed up through a well drain into the well itself. About the same time in another locality, a sewer leaked into the gravity line from an air lift installation, and might have caused a serious outbreak.

Only recently I saw an installation where the pump drippage ran from the pit floor and down the well. In this plant it was the regular thing for the operator to go out to the sewer farm and then come back and track around in the pump pit while he oiled the pump. The fact is, there is probably more sewage contamination of wells than formerly and more than is realized, but sewage itself is becoming less dangerous. However, this should not lead any of us to coast along in the safety zone of water supply purification.

Milk as a Typhoid Carrier

It is some indication that water sanitation has been well handled in this state that there have been no water-borne typhoid outbreaks in California since 1924. Milk far outranks water as a carrier of typhoid in this state. Since 1914, there have been 29 milk-borne outbreaks involving 983 cases, against the 11 water-borne outbreaks involving 660 cases.

So, in the eyes of those of us who are supossed to keep watch on the healthfulness of the public water supplies, we have noted with satisfaction a vanishing typhoid on one hand, and on the other, a high class promotion of chlorination by firms selling the equipment, with consequently more and better installations, and these installations better run by men whose devotion to duty has been a source of admiration. Our only part has been to lend encouragement and spread helpful information to them when they seemed to need it.

We have done a good deal to stimulate an interest in having a large proportion of the chlorinated water supplies provide laboratory tests for free chlorine and baterial count, and sometimes for B. Coli. The laboratory work is particularly helpful because it furnishes the operators with a yardstick by which they can see their own accomplishments. I believe they would now feel lost without such tests. Works dealing with the most highly polluted supplies have whenever possible been kept on a regular analysis with us, either as the sole laboratory control or to supplement their own work. We have also provided a simple form of record on which they keep daily track of the running of the chlorinators. The water departments now provide their own forms but nearly all of the operators send in to us copy of these reports which we scan for any dangerous tendencies in the operation.

Sewage Disposal Problems

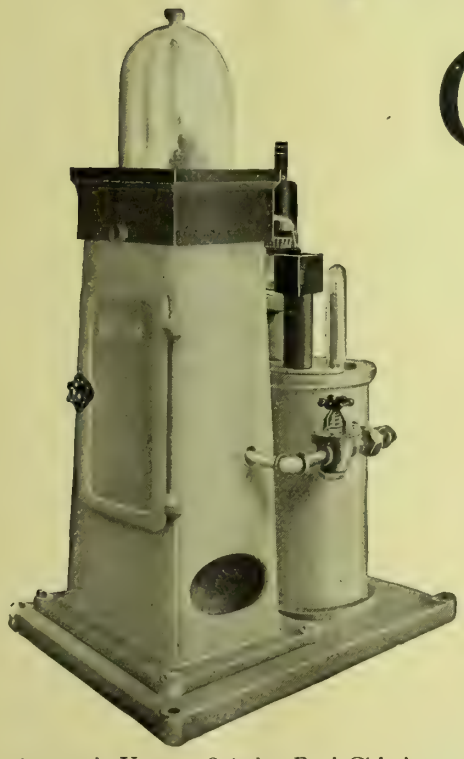
Sewage disposal has diverted much of our attention from water supplies, the demands on us being about three times greater in sewage disposal. In the past fifteen years the state population has more than doubled; state sanitary problems have increased even faster, yet our staff remains now as it was at the beginning, twelve years ago. Few people realize that the state supports but three sanitary engineers for field purposes. We have therefore had to gradually make adjustment to the work created, and in the course of the years have learned pretty well what work can be safely passed over, what can be left to others, and what we cannot very well get rid of ourselves.

It has seemed safe to leave the responsibility for meeting the water works sanitary problems to most waterworks managers and operators in this process of readjustment. If we may judge the typhoid record, the confidence has not been misplaced. This paper is in large part intended as a plea for the recognition of this quiet, conscientious group of public servants whose praises are seldom sung.

It is still necessary to devise some simple way for faster elimination of cross connection. This problem has en-

(*Continued on Page 77*)

Automatic Chlorination



Automatic Vacuum Solution Feed Chlorinator
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Efficiency Tests

on two of these units at the NEW HAVEN WATER COMPANY show an average accuracy of 99.5%.

THE automatic application of liquid chlorine for water sterilization or sewage disinfection is desirable wherever there are rapid changes in the rates of flow or wide variations between maximum and minimum flows.

By eliminating the necessity of over chlorinating the low flows in order properly to chlorinate the high flows—as is frequently necessary with manually operated apparatus—the efficiency of the treatment is increased and interesting savings in chlorine result.

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Super-Chlorination of a Hydrogen Sulfide Water to Eliminate Bacterial Growth

Experiments Conducted at Beverly Hills, California, Show That Super-Chlorination Can Be Utilized as Emergency Measure

By RAY L. DERBY
Sanitary Engineer

THE water supply for the City of Beverly Hills is largely drawn from wells located in an old cienega basin in the southeastern part of the city. These wells average from 250 feet to 500 feet in depth and penetrate strata of probably marine marsh origin. The logs of the wells show sea shells, pieces of wood, peat and similar material.

Although the mineral content of the wells varies greatly, they all contain more or less hydrogen sulfide gas and probably some of the alkaline sulfides. It is believed that this accounts for the high pH value, (7.8 to 8.2,) and the fact that the sulfide is not readily liberated upon aeration of the water.

The sulfide content in the fourteen wells in this section varies from slightly less than one p.p.m. to over twenty p.p.m. in two of the wells. The average is perhaps 8 p.p.m. Four years ago but three of these wells were in use and the sulfide content was low. As the town grew other wells were sunk and all showed an increased amount of sulfide.

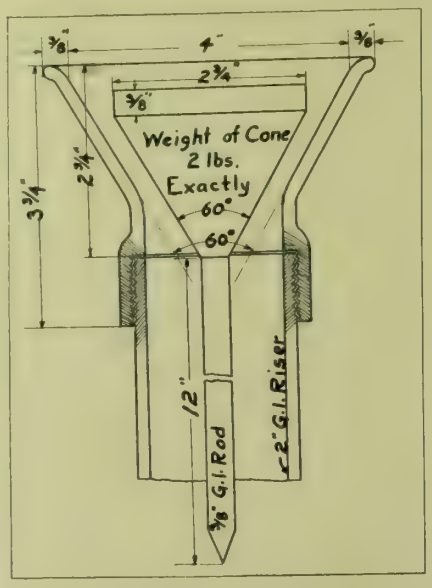
Builds Aeration Plant

An aerating plant was built in 1924 consisting of thirty "Sacramento" nozzles set over a basin 40x50x7 feet deep. This basin led into a weir chamber and from there into a second basin 30x50x7 feet deep from which the pumps took their suction. These basins gave over two hours retention with the consumption at that time. But little trouble was encountered from taste or odor in the water during that summer.

During 1925, however, the peak consumption had nearly doubled over that of 1924 and the plant was inadequate to aerate the water properly. Luxuriant growths of beggiatoa were observed in the wells, around the walls of the aeration plant, and in the pipes leading from the wells to the aeration plant. These growths of beggiatoa, upon dying in the aeration plant basins and in pipe lines after leaving the plant, imparted a musty or moldy taste or odor to the water. At times, and in certain sections of the city where dead ends were likely to occur due to the light draft, a secondary bacterial action took place and hydrogen sulfide was again formed. This, in addition to the usual odor, attacked the pipe, forming iron sulfide.

Methods of Correction Used

Copper sulfate was out of the question because of the copper sulfide formed, and after giving consideration to several other chemicals, including sodium peroxide, chlorine was tried on one line leading from four of the wells to the aeration plant. Previous to this, the trouble had been alleviated by a thorough cleaning and whitewashing of the aerator basins. This would give good water for a period of a week or ten days, after which the trouble would recur. But little effect was noted from this chlorine treatment as the sulfide content of the water was so great that no free chlorine was observed with a chlorine rate of 50 pounds per day in a daily water flow of about 1.25 million gallons.



Sacramento Type Spray Nozzle. This apparatus is made from either cast iron or bronze, depending upon conditions of use.

A second dry feed chlorine machine with a 40-lb. capacity was loaned to the city and both machines were connected to the pump suctions leaving the aerator basins. At this point the water contained a residual sulfide of about 2 or 3 p.p.m. with the inlet water averaging about 10 p.p.m. The daily flow at this time was about 4 M.G.D. The plant was operated for about 15 to 20 hours per day, thus allowing the water to stand in the basins four hours or more before starting the pumps each morning. This caused a decreased amount of sulfide to be present on starting at five or six in the morning and a gradual increase up to the maximum at about one or two P.M., after which it remained constant the rest of the day.

The machines were operated up to their maximum capacity of 90 lbs. per 24 hours with no ortho-tolidin reaction occurring after about noon. A slight improvement in the water near the plant followed this treatment, but before definite results could be noted, cooler weather set in and the worst offenders among the wells were shut down.

Chlorine Treatment

Although the water was now better generally, some chlorination was kept up during the winter in hopes of clearing some of the pipe lines of growths. As the summer of 1926 came on the water began to grow odorous, and the complaints came in thick and fast. A careful chemical study of the system showed that although the water leaving the aeration plant was not excessive in sulfides nor objectionable in taste, yet in certain districts the sulfide content would be nearly double, with a very disagreeable odor in the morning, and frequently resembling ink in color. A bacterial survey was next made and in these worst troubled districts a hydrogen sulphide forming bacteria was found.

A filtration plant was under consideration at this time to remedy all trouble, but as an emergency measure it was decided to chlorinate up to the limit. Accordingly, two vacuum type machines of 200 lbs. per 24 hours capacity each were purchased and set in operation in July, 1926. The maximum capacity of both machines, 400 lbs. per 24 hours, was used. The flow averaged five million gallons per day or a dose of 80 lbs. per million gallons. The dose was applied at a part of the basin where a theoretical retention of about 40 minutes was obtained before reaching the pumps.

(Continued on Page 84)

The "Symbol" of Civilization

The commonplace old faucet is the symbol of civilization. When you are thirsty, or your body feels unclean, or fire threatens you, you turn to your faucet in the most matter-of-fact way, twist the spigot and presto—water!—endless quantities of it.

Few minds travel beyond that indispensable fixture—beyond to the miles of pipe which deliver it—to the filtration and sterilization plants which purify it—to the reservoirs which impound it—and to the men who have made it all possible.

Your water supply today is a triumph of sanitary science and engineering skill. Assisting in this triumphal march, on the Pacific Coast, has been the privilege of

California Filter Company, Inc.

THE MERCHANTS EXCHANGE

LOS ANGELES SAN FRANCISCO SEATTLE

Great Western Electro Chemical Co.

9 MAIN STREET SAN FRANCISCO

WORKS AT PITTSBURG, CALIFORNIA

For Detailed Listings See the Western Buyers' Guide of Waterworks Equipment—Pages 75-76

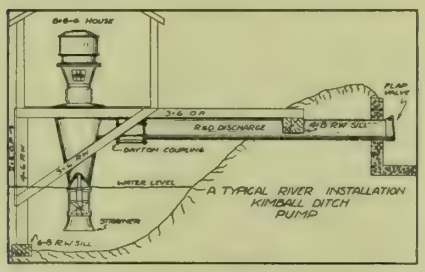
CATALOG SECTION

A Survey of the Leading Supplies and Equipment Used in the Waterworks and Municipal Engineering Bureaus of Western Cities

Kimball Develops New High Capacity Low Lift Pump

The Frank J. Kimball Co., Los Angeles, California, manufacturers of deep well turbine pumps, have developed a very successful high capacity lower head pump of novel design which fills a widespread demand on the part of irrigation, drainage and reclamation projects.

This new low head high capacity pump was designed primarily for raising large quantities of water from ditches, canals, or sumps to a higher elevation, usually from 3 to 25 feet, at high efficiency and low first cost. Previous equipment for



A typical river installation of the Kimball direct flow low lift pump.

this duty was heavy and expensive, difficult to install, required priming, and not well adapted to automatic or remote control, and on low heads, 10 feet or less, particularly low in efficiency.

The Kimball high capacity low head pumps use the well known direct flow impeller which is assembled on the bottom of a tapered discharge column. The pump head is mounted at the top of this tapered discharge column and the complete unit is installed vertically over the river, canal, or sump on a scaffold of timbers. The impeller unit is submerged at all times, making priming unnecessary. The tapered discharge column and the suction strainer are made of sheet steel, welded and asphalt coated, resulting in a unit of extremely light weight, easily portable and economically installed.

Nine sizes have been developed, ranging in capacity from 200 gallons per minute to 10,000 gallons per minute. The pump heads are furnished for belt drive, standard vertical motor direct-connection, and unit motor-head combinations in horsepowers from 2 HP to 100 HP. Standard equipment includes suction strainer with reinforced screen, horizontal or inclined discharge connection, alemite lubrication, and ball bearing heads with reservoir oiling.

Size	Capacity GPM	RPM	Feet Lift	Approx. Weight
10	500 — 1,350	1,000 — 1,500	6	870
11	1,000 — 1,800	900 — 1,500	6	915
12	1,500 — 2,400	800 — 1,200	6	995
15	1,800 — 3,000	800 — 1,200	6	1,175
15	2,400 — 3,600	600 — 900	4	1,450
18	3,000 — 6,000	500 — 900	4	1,835

Recent installations of the Kimball high capacity low head pump include units for Reclamation Disrict No. 307, Sacramento, Calif., Alaska Packers Assn., Sacramento, Calif., Mohawk Valley Municipal Water Conservation Dist., Yuma, Arizona, Reclamation Dist. No. 999, Clarksburg, Calif., Alicia Water Co., Arboga, Calif., and many individual ranchers.

Improved Drilling Methods

New methods of well drilling are being exhibited by the Western Well Works, Inc., of San Jose, California, their convention booth having a miniature well on display.

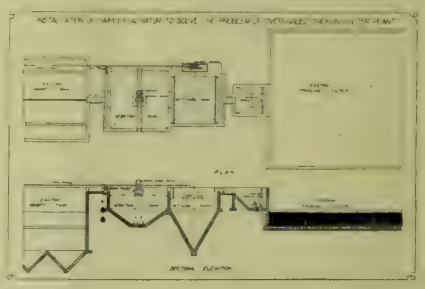
The system used by this company in drilling water wells is as follows: A test hole is drilled by means of a rotary drill. A close log is kept of all formations encountered, drilling proceeding until a water bearing sand is found that will warrant the finishing and developing of the hole. No casing is used during the drillng of this hole, the side walls being plastered with clay and prevented from caving by virtue of the process.

When a satisfactory water bearing sand is found, the test hole is reamed out to a diameter several inches larger than the casing to be used. Machine perforated casing is then set in the hole, and gravel compacted around its exterior. The well is then thoroughly washed, the clay being carried out, and the gravel settling into the water bearing sand, making a larger water recovery area around the casing.

A New Type of Sewage Treatment Plant Has Novel Design

Simplex Ejector Company Develops New Mechanical Surface Aerator for Use in Sewage Plants

The activated sludge process is generally accepted by the sanitary engineering profession as the most efficient method of treating domestic sewage and trade wastes. One of most modern and economical methods of developing an activated sludge known today is by means of the "Simplex" mechanical surface aerator. This apparatus will produce an activated sludge at an extremely low operation cost, due to a very low power consumption. The simplicity of



General Layout of Trickle Filter Plant

the aerator assures a minimum of repair costs.

The worm gear type drive as recently developed provides for complete housing of the gears and bearings which operate in an oil bath. Ball bearings are used throughout for both thrust and alignment so that frictional resistance is reduced to a minimum which gives additional assurance of low power cost. It will be seen that all bearings, steel worm and shaft, bronze worm gear and vertical shaft are protected from the corrosive action of the sewage spray by the substantial cast iron housing. All operating parts of the equipment are above the surface of the sewage liquor and easily accessible. There are no delicate air measuring devices needed, no air blowers to keep in repair, no diffuser plates to remove and clean, nor air pipe lines to maintain. The only attention

New type DBS non-injector solution feed chlorinator.

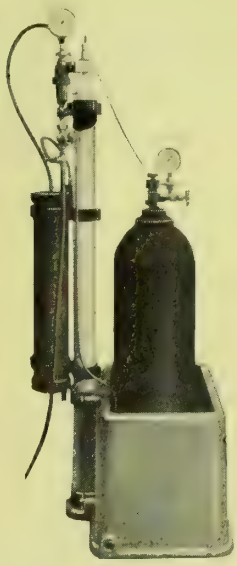
PARADON CHLORINATORS

PARADON is always striving to simplify its apparatus.

A complete new line of non-injector type of solution feed chlorinators is now available with fifty less parts than heretofore.

The PARADON Thermo type chlorinator, the simplest chlorinator ever made, has been further simplified and is now available for use with 100 or 150 pound containers of chlorine as well as 12 pound containers.

There is a PARADON Chlorinator for every type of service, either direct feed or solution feed for every type of waterworks, sewage plant and swimming pool.



New TS Thermo type chlorinator using 100 pound chlorine container.

Send for new Bulletin I-M

PARADON MANUFACTURING CO.

573 Elm Street **Arlington, N. J.**

Pacific Coast Representatives:

CHEMICAL EQUIPMENT CORP.

215 W. 7th St., Los Angeles, Calif.

DBM direct feed chlorinator.

T thermo type solution feed chlorinator.

DBI injector type solution feed chlorinator.

Nearly 600 Paradons are now in service.

For Detailed Listings See the Western Buyers' Guide of Waterworks Equipment—Pages 75-76

required in a mechanical surface aeration plant is regular oiling.

This system brings the activated sludge process with its many advantages within the financial reach of the smaller communities. A low initial investment that will show saving enough over the first cost of a percolating filter type plant to more than justify the operation cost, can usually be shown. In addition there is ample assurance of a better plant effluent without the fly and gnat nuisances and disagreeable odors. Only head enough to insure flow through the plant is needed so that all of the sewage need not be pumped. These are all factors that are responsible for the increasing number of "Simplex" aerator installations. The larger municipalities are also becoming greatly interested in the savings in power costs evidenced by the installations in service.

A small single unit plant has been in successful operation at the Montezuma Boys Home at Los Gatos, California for the last 12 months treating a strong sewage. The City of Dunsmuir, California is now operating an eight unit plant and other plants are in contemplation in this western section of the country.

Elevated Tanks for Storage

Large Capacity Elevated Tanks Becoming Accepted Practice in Waterworks Systems

Municipal officials and engineers on the Pacific Coast recognized the advantages of gravity storage in large waterworks systems several years ago and began making such installations. Cities in other portions of the United States are following suit. They are appreciating that the benefits of the elevated tank are not for the small cities alone.

Charleston, South Carolina has installed a 2,000,000 Horton elevated tank while Miami, Florida, Kenmore, New York, and Springfield, Illinois, have tanks of similar ellipsoidal-bottom design and 1,000,000 gallons capacity. Many others have 500,000-gallon and 750,000-gallon tanks.

Elevated steel tanks have improved service in large waterworks systems at a reduction in cost. They have allowed the pumps to be operated at an economical constant rate and at the same time held the pressure in the distribution system uniformly high.

It is gratifying to see a practice of such Pacific coast cities as Portland Oregon; Stockton, Glendale, El Centro Huntington Park, and Ritzville, California; Seattle, Hillyard and Pasco Washington, being accepted by the municipal engineering profession.

New Automatic Vacuum Type Chlorinator Perfected

Pioneer Chlorine Control Engineers Perfect New Water Sterilization Apparatus for Use on Variable Flows

Outstanding among the recent developments of Wallace & Tiernan Co., Inc., Newark, New Jersey, manufacturers of chlorine control apparatus—who have offices established in the principal cities of the country and on the west coast maintain branch offices at Los Angeles, San Francisco and Seattle—is the Automatic Vacuum chlorinator which has recently been installed by Bureau of Water Works and Supply of the City of Los Angeles.

The automatic application of liquid chlorine for water sterilization or sewage disinfection is desirable wherever there are rapid changes in the rate of flow or wide variations between the maximum and minimum flows. By elimi-

Wallace & Tiernan Type MSV Vacuum Chlorinator

nating the necessity of over chlorinating the low flows in order properly to chlorinate the high flows—as is frequently necessary with manually operated apparatus—the efficiency of the treatment is increased and interesting savings in chlorine result.

The vacuum type of automatic chlorinator makes use of the principle of control so successfully used by Wallace & Tiernan in their Type MSV apparatus, several thousands of which are now in use throughout the world. Two of the new type automatic vacuum chlorinators have been in operation for the New Haven Water Works Company, New Haven, Connecticut, for a period of two years. Efficiency tests of these units show an average accuracy of 99.5 per cent. On one test over a twenty-four hour period with readings five minutes apart, the theoretical flow of chlorine should have been 5.23 pounds, the actual flow was 5.25 pounds; on a second test the theoretical chlorine flow should have been 14.50 pounds, the actual flow was 14.25 pounds while in the third test, the theoretical flow of chlorine should have been 16.20 pounds and the actual flow was 16.50 pounds.

The Western Avenue Pumping Station of the City of Chicago—the largest pumping station in the world—is equipped with these automatic chlorinators.

Waterproofed Reservoirs Used by City Water Systems

Waterproof Point Company Has Developed Product Designed to Meet Severe Western Conditions

It is likely very few concerns, especially manufacturers of reservoir waterproofings, have little, or no conception of western solar ray heat. It is likely a fact that in some of our cities, near the desert, sun heat will register in excess of 185 degrees. This causes the joint compounds to lose their light oils and quickly dry up, while others run down the slopes, adding further trouble to the City Water Superintendent's load of troubles.

In local work, we have noted under wooden roof, the concrete temperature to be 106 degrees Fahr. (one inch below the surface) while the air temperature to be 108 degrees Fahr.; 118 degrees at the top of the slopes near the roof and, on top of the reservoir exposed to the sun, to register 146 degrees Fahr. This is not the highest we have registered locally.

At points near the edges of the deserts, the waterproofing of jointed and open reservoirs is quite a problem. Usually the joints are on close centers, the concrete being in summer temperature of 175 degrees or higher, then suddenly being subjected to two or three inches of hail (ice) and then in a few hours, returning to the hot temperatures again, such phases fairly make the joint compounds dance with contraction and expansion during such unequal conditions.

We have seen the complete failure of compounds designed for eastern service, such as bleeding joints, displaced membranes, etc. It is likely that these materials, when used in their own country would give good service, but the western country has a climate all its own. In these same reservoirs where certain eastern materials have failed, Waterproof Paint Company's Mastic joints have functioned perfectly, requiring no maintenance during the past 20 years, because they were made to meet certain extremes of temperatures.

The Three Best Bets of the Convention—

STRENGTH RESISTANCE
ASTCO
DURABILITY
TRADE MARK REG.

"ASTCO" SEAMLESS STEEL WATER PIPE

For High or Low Pressure Welded Lines.

See our representative, Mr. C. F. Keefe, at the convention or at the Vendome Hotel.

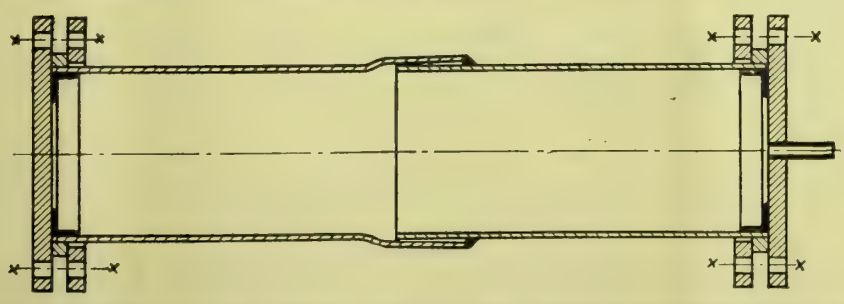
No. 1 Highest possible tensile strength.

No. 2 The greatest possible resistance against corrosion.

No. 3 Eliminates 50% of your joints and cut time required for installation with our 40-foot joints.

PIPE FURNISHED: Slip Joint, Plain End or Bevelled for Welding. Dipped or dipped and wrapped as required.

Hydrostatic Tests on Slip Joint Line Pipe



Dimension of Test Piece				Test Results		
Test No.	I. D. Inches	Wall Thickness Inches	Length Feet	Weld leaky at ... lbs. per sq. in.	Weld Tight until broken ... lbs. per sq. in.	Corresponding pulling load when weld has been broken ... lbs.
1	3.937	.157	13	4125	.....	.....
2	3.937	.157	13	.....	5120	75,300
3	3.937	.157	13	.....	5120	75,300
4	7.874	.216	13	.....	2845	157,500
5	7.874	.216	13	.....	5120	284,000
6	7.874	.216	13	.....	3129	174,000
7	9.843	.276	13	.....	3698	322,000
8	9.843	.276	13	.....	3698	322,000
9	9.843	.276	13	3129	.....	.....

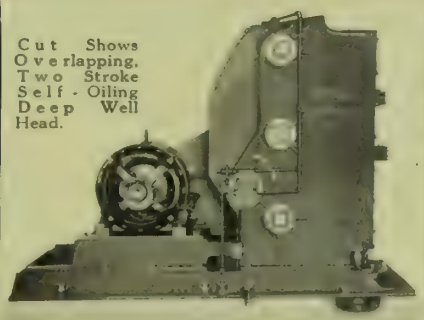
American Seamless Tube Corporation of California

Petroleum Securities Building, Los Angeles, California

535 5th Ave., New York City

1211 Neils Esperson Bldg., Houston, Texas

For Detailed Listings See the Western Buyers' Guide of Waterworks Equipment—Pages 75-76



Cut Shows Overlapping, Two Stroke Self-Oiling Deep Well Head.

If it's for a

DEEP WATER WELL

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Lawrenceburg, Ind.

Manufacturers of
DEEP WELL PUMPS
Single Stroke—Double Acting—
Two Stroke
Deep Well Cylinders and Pump Rods of All Types
The COOK Patent Brass Tube Well Strainer
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A thorough Textbook on the theory of hydraulics and on the principles of hydraulic machinery. This book aims to show the student of hydraulics and irrigation how problems in hydraulic engineering can be reasoned out and solved by practical appeal to first principles.

348 pages. 5¾ by 9. Fully illustrated with diagrams and charts. All orders should be accompanied with cash. Allow ample time for shipment from the publishers. $3.00 postpaid.

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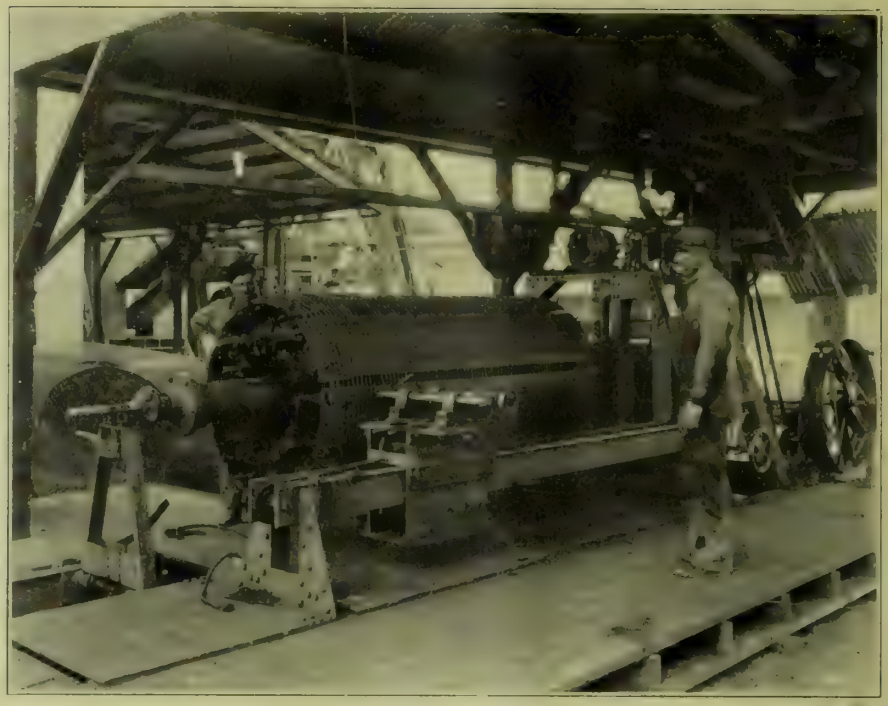


Heavy steel wire is wound on collapsible mandrel, properly spaced under desired tension. The above shows this machine in operation making 42-inch cages.

Intricate Device Designed by Concrete Pipe Company

Western Manufacturer Designs Machine Which Scientifically Builds Reinforcing Cages

Realizing that the fabrication of the steel cage which comprises the reinforcing element of centrifugal cast concrete pipe was of prime importance to the process and product involved, the Western Concrete Pipe Company recently designed and built a machine for use in the making of Hume Centrifugally Spun pipe. This apparatus is an improvement on the English Hume machine which heretofore has been in wide use in England, Australia, South Africa and New Zealand. The cost of this new device is about $5,000.00 but its capacity is doubled and attendant labor cost is decreased. The new product is a substantial improvement over the old.

This machine makes cages in regular lengths of 8 feet, and in diameters ranging from 24 inches to 54 inches. The steel is wound automatically on a collapsible drum, with the feed so arranged that millimeter exactness is secured in the spacing. Numbers eight, ten or twelve gauge wires are used in the fabrication of cages. Two, three and four layers are used, depending on the pressure the pipe is to stand, these layers being separated by longitudinal and diagonal reinforcement.

In the winding of the cage the steel is always under sufficient tension to thoroughly straighten the wire and deform the longitudinal wires enough so that they hold the circumferential steel in position during the making period, and the finished product is symmetrically true and rigid. The deflection or curve in a cage is imperceptible when one end is raised from the ground.

When the cage has been completed the loose wire ends are tied, the drum is collapsed, the cage is displaced horizontally, and is then ready for placement in the pipe form. Owing to the fact that the ends of the cage are beveled slightly inward, the cage, when inserted in the pipe form, extends into both the bell and the spigot of the pipe. Thus is produced a steel reinforcement cage symmetrically and rigidly fabricated, giving equal and true reinforcement for the entire length of the pipe. The centrifugal action in spinning of the pipe places this steel under tension in the concrete and a truly "reinforced concrete pipe" is the result.

Riverside Concrete Pipe Line

(Continued from Page 39)

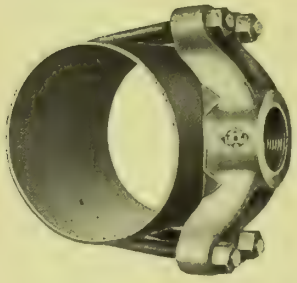
of ten days before it was installed in the trench. As soon as the pipe was spot welded in the trench, it was backfilled between bellholes. The trench material was a sandy loam which was well consolidated under the haunches of the pipe by flooding the backfill. The line is about completed and has been subjected to test under a pressure of 150 per cent of the line pressure without any leakage at all.

The work was executed by H. W. Rohl, Contractor of Los Angeles.

JAMES JONES COMPANY

201 LEROY STREET

LOS ANGELES, CALIF.



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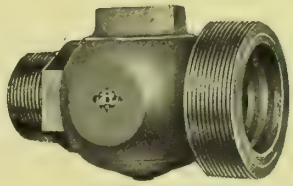
WATER, GAS *and* STEAM



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CALIFORNIA TYPE

No. 105½

Our new catalog "K" on fire and wharf hydrants just out—write for it.

Manufactured by

M. GREENBERG'S SONS

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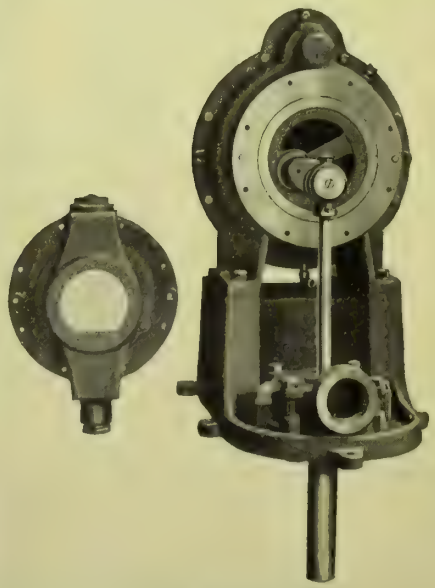

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Alamo Dorward Rotary Power Head

For deep well cylinders, either single or double acting.

TOTALLY ENCLOSED. POSITIVE SELF-OILING. ABSOLUTE NOISELESS IN OPERATION.

When used with our double acting cylinders it's the most efficient deep well pump made.

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PUMP HOUSE

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STEEL TANKS
for
water
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WELL CASING

RIVETED WATER PIPE

Irrigation Pipe
All Sizes

Truck Tanks

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Los Angeles Mfg. Co.
2500 E 23rd. St.
P.O.Box 37
Arcade Station
Los Angeles
California

New Thermo Type Chlorinator

Paradon Thermo Control Type TS Chlorinator Equipped to Operate Under the Bull Patents

The Paradon Manufacturing Company, Arlington, New Jersey, have developed a new thermo type solution feed chlorinator known as their Type TS. This chlorinator uses a standard 100 pounds cylinder of chlorine. The cylinder is placed in a water bath. In as much as the temperature of water varies but little from day to day, this water bath keeps the cylinder at an approximately constant temperature, therefore the pressure remains constant and thus the usual chlorine pressure reducing and constant pressure devices are eliminated, thereby greatly simplifying construction.

The chlorine passes from the cylinder

through a control valve and then into a glass-bubbling type volumetric motor, from which a chlorine and water solution is drawn into an injector, which is used to apply chlorine to the water or sewage to be chlorinated. Part of the auxiliary water supply operating the injector is used to keep a small amount of water circulating in the water bath.

The bubbling motor is enclosed in a glass cylinder which fills with water just as soon as the injector is in operation due to the vacuum created by the injector. This water acts as a medium to make visible the bubbles of gas released from the motor. As soon as the injector ceases to operate, the vacuum inside of the glass cylinder is released and the water level drops to the level of the overflow of the water bath, unsealing the bottom of the glass cylinder. The apparatus is mounted on a vitrified enamel pedestal.

The manufacturer states that this machine is non-flooding, and is extremely simple, it being possible to construct the machine with less than one-third the usual number of parts. All parts are readily accessible and interchangeable.

The thermo type TS chlorinator is applicable for treating small water supplies and small sewage plants and also for practically all swimming pools.

New Equipment Announced by A. D. Cook Company

The Cook Self-Oiling Deep Well Head Based on A. W. W. A. Specifications Developed by Pioneer Manufacturer

A. D. Cook, Inc., Lawrenceburg, Ind., is offering an overlapping two-stroke, self-oiling, deep-well pump in seven sizes from 3 to 30 H. P. The firm designates this pump as the Type P. H. The massive pump frame serves also as an oil-retaining casing. The flow of motion is from a pinion shaft through two gears, two bell cranks to the two plungers. The overlapping stroke results from each plunger moving down faster than it moves up, due to the uniformly changing lengths of the power arm of each bell crank. Advantage has been taken of the change of length in the power arm so that there is a short lever arm on down stroke with no load and long lever arm on upstroke with load.

The scheme of lubrication provides that oil poured into the oil reservoir in the pump base be pumped by a geared oil pump into a tilting pan on the upper bell crank. Oil from the tilting pan floods bearings and gears, doing away with most of the noise common to metallic gears and increasing the life of all wearing surfaces. All oil returns to the oil reservoir. A water baffle prevents water from the packing boxes getting into the oiling system of the pump. This pump is regularly provided for either belt or motor drive.

A new hydrant of the compression type has recently been developed by A. D. Cook, Inc., to meet the specifications of the A.W.W.A. and the National Board of Fire Underwriters. Bonnet, standpipe and hydrant shoe are impressive because of their sturdiness. Valve parts are simple in construction and positive in action. Bonnets with varying numbers and sizes of hose connections are interchangeable. The standpipe area is 196 per cent greater than the valve area, thus eliminating friction loss and increasing flow. Because of changes in street grade after installation, the height of hydrant may be modified with or without displacement of standpipe.

For Detailed Listings See the Western Buyers' Guide of Waterworks Equipment—Pages 75-76

New Method of Applying Asphalt Protective Coatings

The Use of Asphalt as a Waterproofing Agent and Corrosion Preventative for Pipe Lines

The value of a proper asphalt for the protection of concrete and steel from the attacks of moisture, alkalies, acids, acid fumes, corrosive gases, etc., as well as for waterproofing of masonry is universally recognized. The problems connected with its use have been:—

1. The proper physical properties required of an asphalt for this particular purpose.
2. The selection of the proper raw or crude base from which such an asphalt may be obtained.
3. The selection of a thorough and controllable refining process.
4. The conversion of this asphalt to a physical condition that will permit of cold application without recourse to solvents.

It is generally appreciated among engineers that hot asphalt applications adhere very poorly to cold or wet surfaces and that this process frequently fails because of human error through overheating the asphalt thereby ruining most of its valued waterproofing properties.

By a new manufacturing process a known asphalt is broken into minute particles and dispersed in water, the water acting to suspend the particles to keep them from flowing together and, at the same time, as a vehicle for spreading the particles. When spread cold on a surface of masonry or steel the water evaporates, the asphalt particles flow together and unite and when dry there is left behind, not a thin, fragile skin like paint but a dense, thick, plastic film of asphalt exactly as if the asphalt had been applied hot with a mop.

This material is known as Krodeproof and is manufactured by the Lewis Asphalt Engineering Corporation, 30 Church Street, New York who are represented by Francis & Schreck, Inc., Insulating Engineers, 2145-47 Sacramento Street, Los Angeles, Calif.

Krodeproof, the manufacturer claims, is essentially not a new material but a new and economical method of applying a well known material whose value and protective qualities are universally recognized. It has remarkable adhesive qualities and may be applied to damp or even wet surfaces with no loss in adhesive value. It does not require a primer and is non-inflammable, odorless and chemically neutral containing no oil to dry out, therefore will never become brittle and consequently will not crack, remaining tacky and ductile indefinitely.

JONES-THORNE & COMPANY, Inc.

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HYDRAULIC & GAS PRODUCING MACHINERY

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MATHEWS' PATENT-FIRE-HYDRANT

HYDRAULIC VALVES & FITTINGS

SAN FRANCISCO
1660 Russ Bldg.
Sutter 2996

Air chamber designed by E. E. Everett for G. Ferro & Co., Ventura, Calif.

WATER SURGE and WATER HAMMER

Successfully Controlled by

Air Chambers

Scientifically designed and figured for high pressure pipe lines.

A large number are in use in Ventura County, Calif.

E. E. EVERETT
Civil and Hydraulic Engineer
2150 Lincoln Drive
Ventura, Calif.

For Detailed Listings See the Western Buyers' Guide of Waterworks Equipment—Pages 75-76

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PETROLEUM PRODUCTS

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EFFICIENT LUBRICATION

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the operation of all types of oil and gasoline driven machinery.

Richfield Oil Company

A. G. Bartlett Bldg.
Los Angeles, California

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"It's O K"
What's O K?

THE STERLING WAY OF PUMPING

STERLING PUMPS Are Sterling Made

We Can Convince You

Let Us Have Your Pumping Problems

Sterling Pump Works, Inc.

Stockton, Calif.

McWane Increases Preferred Stock Capitalization

Plant Capacity to be Doubled Allowing Manufacture of a New Light Weight Pipe in Sixteen Foot Lengths

The McWane Cast Iron Pipe Company, of Birmingham, Alabama, is reported as increasing its preferred capitalization from $500,000.00 to $1,000,000.00. The company announces this entire issue will not be sold at the present time but only a sufficient proportion to complete improvements now under way.

In this connection, their announcement points out that the cast iron pipe industry has been undergoing a gradual process of evolution, not only in the methods of manufacture but in the reduction of weights for given services. The McWane Company has developed its own system of manufacturing a sand-cast pipe which it is claimed will compete advantageously with the other lighter-weight pipe being put on the market.

In the developments under way, mechanical operations will be substituted for the hand methods that have been used in the initial stages. Experimental work on these new mechanical features is said to have been in progress for some time, and it is said that the success of these experiments has justified going ahead with the improvements in a big way.

As a result of these new installations the tonnage of the plant is expected to be practically doubled, and the length of the pipe made in this new mechanically-equipped unit will be 16 foot.

The range of sizes heretofore made will also be increased and pipe as large as 12 inches in diameter will be made in this new unit. The new processes are reported as all being covered by patents.

De Laval Displays Antique at Waterworks Show

Turbo-Generator Built in 1901 First Commercial Application of Impulse Type Machine

An unusual exhibit is being presented by the De Laval Steam Turbine Company at the Convention of the California Section of the American Water Works Association in San Jose, which, it is believed, will be of more than ordinary interest.

At all of the Waterworks conventions of the past few years, this company has displayed its standard pumps and parts, with which engineers and superintendents are now quite familiar. This year, a small turbo-generator of an early type, but of unusual performance characteristics, will be displayed as an illustration of that production which has established the De Laval reputation for high quality and efficiency.

The unit was built in 1901 for locomotive headlighting purposes and has a capacity of one kilowatt, generating 115 volt direct current at a speed of 5000 RPM. The turbine operates at 40,000 RPM with a steam pressure of 200 pounds and exhaust to atmosphere. The speed reduction is obtained by double helical gears and the pinion shaft illustrates the famous flexible feature introduced with these machines.

This type of turbine is as originally developed by Dr. De Laval and was the first commercial application of the impulse turbine. Although now obsolete because of small capacity, these machines are typical examples of the degree of excellence which enters into the construction of present day De Laval units of all types.

The world's largest pumping station, in Chicago, Illinois, is equipped with De Laval centrifugal pumps and more than two hundred other American cities use De Laval pumps aggregating a daily capacity of more than eight billions of gallons.

The products of this company most used in waterworks plants are centrifugal pumps for any capacity and head and all forms of drive; reduction gears for agitators; flexible couplings; steam turbines and water turbines.

Representatives of the company will be glad to give full information on these applications. California district offices are maintained at Los Angeles and San Francisco.

Sterling Perfects Unitype Drive for Pumps

Manufacturers of Well Known Pumping Equipment Design New Type Drive for all Kinds of Machinery

The development of the Unitype drive, by the Sterling Pump Works, of Stockton, California, is one of the outstanding features of the pump industry. This is a radical departure from former drives, which heretofore have been constructed with all leather link flexible couplings. It was the aim of the manufacturer to produce a drive which should suit any and every make of motor. In the production of this drive, all superfluous parts have been eliminated, making a compact, composite design, which is uniform, and allows the very desirable feature of interchangeability of parts. These parts are made up in quantity, stocked at all distribution stations,

(*Continued on Page 89*)

WESTERN BUYERS' GUIDE

OF WATERWORKS AND SEWAGE DISPOSAL EQUIPMENT

WESTERN WATERWORKS presents the following Buyers' Guide to the leading Western sources for waterworks equipment and auxiliary supplies. Purchasing departments, engineers and all others who do ordering or specifying will find this department of great practical value, listing as it does the most representative lines handled by western manufacturers and distributors. The listings herewith are not, as yet, entirely complete but will become more so with future issues of the publication. To this end, the publishers bespeak the active co-operation of the companies whose products are included below. Send all corrections or additional listings by mail and at the earliest possible before press date. For addresses of firms listed below, see advertisements in the foregoing pages of WESTERN WATERWORKS.

AIR LIFTS
Kimball Co., Frank J.
Woodin & Little

AIR CHAMBER DESIGN
E. E. Everett

ANTICORROSIVES
Hill, Hubbell & Co.
Everlasting Paint & Sales Co.
Lewis Asphalt Engineering Co.
Francis & Schreck, Inc.
Pioneer Paper Co.
Waterproof Paint Co.

BEARINGS, BALL
Masterson, Jos. A & Co.
Silverberg & Co.

BEARINGS, ROLLER
Masterson, Jos. A & Co.
Silverberg & Co.

BOXES, METER
Art Concrete Works
Forni Mfg. Co.

BOXES, SERVICE, ROADWAY AND VALVE
Art Concrete Works
Forni Mfg. Co.

BRASS GOODS
James Jones Company
Crane Co.

CASING, WATER WELL
American Steel Pipe & Tank Co.
Los Angeles Mfg. Co.
Montague Pipe & Steel Co.
Western Pipe & Steel Co.

CATCH BASIN COVERS
Art Concrete Works

CHEMICALS
Great Western Electro-Chemical Co.

CHEMICAL FEEDING APPARATUS, DRY
Wallace & Tiernan Co.

CHLORINE
Great Western Electro-Chemical Co.

CHLORINATING EQUIPMENT
Wallace & Tiernan Co.
Paradon Engineering Co.

COATINGS, PROTECTIVE
Everlasting Paint & Sales Co.
Hill, Hubbell & Co.
Lewis Asphalt Engineering Co.
Pioneer Paper Co.
Waterproof Paint Co.

CONCRETE PRESERVATIVE
Everlasting Paint & Sales Co.
Hill, Hubbell & Co.
Lewis Asphalt Engineering Co.
Pioneer Paper Co.
Waterproof Paint Co.

CONSULTING ENGINEERS
Smith-Emery Co.

CONTRACTORS, WELL
Roscoe Moss Co.

COUPLINGS, FLEXIBLE
Byron Jackson Pump Mfg. Co.
Woodin & Little
De Laval Steam Turbine Co.
Crane Co.

DAMPPROOFINGS
Hill, Hubbell & Co.
Everlasting Paint & Sales Co.
Lewis Asphalt Engineering Co.
Pioneer Paper Co.
Waterproof Paint Co.

DRILLING RIGS
Commercial Iron Works
Roscoe Moss Co.

DRILLING SUPPLIES
Mills Iron Works
Commercial Iron Works
Roscoe Moss Co.

ENGINES
Commercial Iron Works
Fairbanks, Morse & Co.
Western Machinery Co.
Woodin & Little

ENGINES, DIESEL
Western Machinery Co.
Fairbanks, Morse & Co.

FILTERS, WATER
California Filter Co.
Wallace & Tiernan Co.

FILTER PLANTS
California Filter Co.
Wallace & Tiernan Co.

FITTINGS, PIPE
Commercial Iron Works
Woodin & Little
McWane Cast Iron Pipe Co.
U. S. Cast Iron Pipe & Fdry. Co.
Crane Co.

FLUMES, LENNON TYPE
Calif. Corrugated Culvert Co.

GATES, DRAINAGE & PRESSURE
Calif. Corrugated Culvert Co.

GAUGES & RECORDERS
R. W. Sparling
Leopold, Volpel Co.

GEARS, WORM & HELICAL
De Laval Steam Turbine Co.

GREASE, TULC
Masterson, Jos. A. & Co.

HYDRANTS, FIRE
M. Greenberg's Sons
R. D. Wood & Co.
Jones-Thorne & Co.
A. D. Cook, Inc.

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Kimball, Frank J. Co.

JACKS, HYDRAULIC
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Neptune Meter Co.
National Meter Co.

METERS, CREST
Badger Meter Mfg. Co.
Neptune Meter Co.
National Meter Co.

METERS, ELECTRIC
Westinghouse Electric & Mfg. Co.

METERS, FLOW
Badger Meter Mfg. Co.
Neptune Meter Co.
National Meter Co.
R. W. Sparling
Worthington Co., Inc.

METERS, WATER
Badger Meter Mfg. Co.
Neptune Meter Co.
National Meter Co.
R. W. Sparling
Worthington Co., Inc.

METERS, MAIN LINE
R. W. Sparling

METER DISCS
Badger Meter Mfg. Co.
National Meter Co.
Neptune Meter Co.
R. W. Sparling
Worthington Co., Inc.

METERS, TURBINE TYPE
Worthington Co., Inc.

METER BOXES
Art Concrete Works
Forni Mfg. Co.

MOTORS & MOTOR CONTROL
Westinghouse Electric & Mfg. Co.
Woodin & Little
Fairbanks Morse & Co.

PIPE, CONCRETE
United Concrete Pipe & Const. Co.
Western Concrete Pipe Co.

PIPE, CORRUGATED
Calif. Corrugated Culvert Co.
American Steel Tank & Pipe Co.

PIPE, RIVETED STEEL
Western Pipe & Steel Co.
Los Angeles Mfg. Co.
Lacy Manufacturing Co.
Montague Pipe & Steel Co.

PIPE FITTINGS
Commercial Iron Works
Woodin & Little
James Jones Co.
Crane Co.

PIPE FITTINGS, BRASS
James Jones Co.
Crane Co.

PIPE FITTINGS, BRONZE
James Jones Co.
Crane Co.

PIPE & FITTINGS, CAST IRON
Crane Co.
Los Angeles Mfg. Co.
Lacy Mfg. Co.
Fairbanks Morse & Co.
Montague Pipe & Steel Co.
McWane Cast Iron Pipe Co.
U. S. Cast Iron Pipe & Fdry. Co.
Pacific States Cast Iron Pipe Co.

PIPE & FITTINGS, CONCRETE
Western Concrete Pipe Co.
United Concrete Pipe & Const. Co.

PIPE, STORM DRAIN
United Concrete Pipe & Const. Co.
Western Concrete Pipe Co.

PIPE, CONCRETE PRESSURE
Western Concrete Pipe Co.

PIPE DIP & COATINGS
Hill, Hubbell & Co.
Everlasting Paint & Sales Co.
Lewis Asphalt Engineering Co.
Pioneer Paper Co.
Waterproof Paint Co.

PIPE FITTINGS, MALLEABLE AND FORGED
Crane Co.

PIPE FITTINGS, SERVICE SPECIAL
James Jones Co.
Crane Co.

PIPE & FITTINGS, WOOD
Pacific Tank & Pipe Co.

PIPE, LOCK BAR STEEL
Western Pipe & Steel Co.

PIPE, WELDED STEEL
Western Pipe & Steel Co.

PIPE, RIVETED STEEL
Western Pipe & Steel Co.
Lacy Manufacturing Co.
Los Angeles Manufacturing Co.
Montague Pipe & Steel Co.

PIPE, WOOD
Pacific Tank & Pipe Co.

PENSTOCKS
Western Pipe & Steel Co.
Lacy Manufacturing Co.

PRESSURE SYSTEMS
Byron Jackson Pump Mfg. Co.
Fairbanks, Morse & Co.
Woodin & Little

PUMPS, CENTRIFUGAL
De Laval Steam Turbine Co.
Layne & Bowler
Byron Jackson Pump Mfg. Co.
Fairbanks, Morse & Co.
Kimball, Frank J. Co.
Price, G. W. Pump & Engine Co.
Sparling, R. W.
Sterling Pump Works
Woodin & Little
American Well Works
Worthington Pump & Machinery Co.

PUMPS, DEEP WELL
Byron Jackson Pump Mfg. Co.
American Well Works
Price, G. W. Pump & Engine Co.
Sterling Pump Works
A. D. Cook, Inc.
Layne & Bowler Corp.

PUMPS, ROTARY
Woodin & Little
Fairbanks, Morse & Co.
Byron Jackson Pump Mfg. Co.

PUMPS, PLUNGER TYPE
Pomona Mfg. Co.
Woodin & Little
A. D. Cook, Inc.

PUMPS, TURBINE
Sterling Pump Works
Price, G. W. Pump & Engine Co.
Pomona Mfg. Co.
Fairbanks, Morse & Co.
American Well Works
Layne & Bowler Corp.
Byron Jackson Pump Mfg. Co.
Kimball, Frank J. Co.

PUMP VALVES
Pomona Mfg. Co.
Woodin & Little

PUMP HOUSES
California Corrugated Culvert Co.
Los Angeles Mfg. Co.

PUMPS, DRAINAGE
Byron Jackson Pump Mfg. Co.
G. W. Price Pump & Engine Co.
Woodin & Little

RESERVOIR LINING
Waterproof Paint Co.
Hill, Hubbell & Co.
Lewis Asphalt Engineering Co.
Everlasting Paint & Sales Co.

SERVICE COCKS
Crane Co.

SEWAGE PUMPS, VERTICAL & HORIZONTAL
American Well Works

SEWER PIPE
United Concrete Pipe & Const. Co.
Western Concrete Pipe Co.

SOFTENING EQUIPMENT, WATER
California Filter Co.
Wallace & Tiernan Co.

STANDPIPES, STEEL & IRON
Los Angeles Mfg. Co.
Lacy Mfg. Co.
Montague Pipe & Steel Co.
Western Pipe & Steel Co.

STERILIZATION EQUIPMENT
California Filter Co.
Paradon Mfg. Co.
Wallace & Tiernan Co.

SWITCHBOARDS
Westinghouse Electric & Mfg. Co.

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Calif. Corrugated Culvert Co.
Lacy Mfg. Co.
Los Angeles Mfg. Co.
Montague Pipe & Steel Co.
Western Pipe & Steel Co.

TANKS & TOWERS
Pacific Tank & Pipe Co.
Western Pipe & Steel Co.

TRENCHING MACHINES
Ruth Dredger Sales Corp.

TURBINES, STEAM
De Laval Steam Turbine Co.

VALVES, AUTOMATIC CONTROL
R. W. Sparling
Commercial Iron Works
Woodin & Little
Crane Co.

VALVES, BUTTERFLY
Commercial Iron Works
Woodin & Little
Byron Jackson Pump Mfg. Co.
Commercial Iron Works
Woodin & Little
Crane Co.

VALVES, FLAP
Byron Jackson Pump Mfg. Co.
Commercial Iron Works
Martin Iron Works

VALVES, FOOT
A. D. Cook, Inc.

VALVES, GATES
Pomona Mfg. Co.
Calif. Corrugated Culvert Co.
Woodin & Little

VALVES, WATER RELIEF
Neptune Meter Co.

WATER FILTRATION PLANTS
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Paradon Mfg. Co.
Wallace & Tiernan Co.

WATER SOFTENING EQUIPMENT
California Filter Co.
Paradon Mfg. Co.
Wallace & Tiernan

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National Water Main Cleaning Co.

WATERPROOFING COMPOUNDS
Everlasting Paint & Sales Co.
Hill, Hubbell & Co.
Lewis Asphalt Enineering Co.
Waterproof Paint Co.

WATER WASTE SURVEYS
Smith-Emery Co.

WELL DRILLING CONTRACTORS
Roscoe Moss Co.

WELL DRILLING EQUIPMENT
Mills Iron Works
Roscoe Moss Co.

WELL SCREENS
Cook, A. D. Inc.
Layne & Bowler Corp.

WELL CYLINDERS
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WELL SUPLLIES
Commercial Iron Works
Roscoe Moss Co.
Cook, A. D. Inc.
Mills Iron Works

Exhibitors at the A. W. W. A. Convention, California Section Scottish Rite Temple, San Jose, Cal., October 5th to 8th, 1927

American Brass Co. - - - - - - - - - - - *San Francisco*
American Cast Iron Pipe Co. - - - - - - - *Los Angeles*
American Seamless Tube Corp. - - - - - - - *Los Angeles*
American Well Works - - - - - - - - - *Aurora, Illinois*
Art Concrete Works - - - - - - - - *Pasadena-Oakland*
Byron Jackson Pump Manufacturing Co. - - - - *L. A.-S. F.*
California Corrugated Culvert Co. - - - - - - - *Berkeley*
California Filter Co. - - - - - - - - - - *San Francisco*
California Meter Co. - - - - - - - - - - - *Los Angeles*
Cement Gun Construction Co. - - - - - - - - *San Francisco*
Chapman Valve Company - - - - - - - - - *Los Angeles*
Chicago Bridge and Iron Co. - - - - - - - - *San Francisco*
De Laval Steam Turbine Co. - - - - - - - - *L. A.-S. F.*
Everlasting Paint Co. - - - - - - - - - - *Los Angeles*
Forni Manufacturing Co. - - - - - - - - - - *Oakland*
Frank Kimball and Co. - - - - - - - - - - *Los Angeles*
Giant Manufacturing Co. - - - - - - - *Council Bluff, Iowa*
Greenberg Brass Foundry Co. - - - - - - - - *San Francisco*
Grinnell Co. - - - - - - - - - - - - - - *San Francisco*
Hersey Manufacturing Co. - - - - - - - - - *L. A.-S. F.*
James Jones Brass Works - - - - - - - - - *Los Angeles*
Kennedy Valve Co. - - - - - - - - - - - *San Francisco*
Layne and Bowler Co. - - - - - - - - - - *Los Angeles*
Modern Irrigation (*Western Waterworks*) - - - - - - *L. A.*
Montague Pipe and Steel Co. - - - - - - - *San Francisco*
Mueller Manufacturing Co. - - - - - - - - - *L. A.-S. F.*
National Meter Co. - - - - - - - - - - - - *L. A.-S. F.*
National Tube Co. - - - - - - - - - - - - *San Francisco*
Neptune Meter Co. - - - - - - - - - - - - - *L. A.-S. F.*
Nicol, B. and Co. - - - - - - - - - - - - - *San Francisco*
Pacific Pump Co. - - - - - - - - - - - - - *Los Angeles*
Pacific States Cast Iron Pipe Co. - - - - - - - *Los Angeles*
Philbrook Spring Clamp Co. - - - - - - - - - *Los Angeles*
Pittsburg Des Moines Steel Co. - - - - - - - *San Francisco*
Pomona Pump Co. - - - - - - - - - - - - - - *Pomona*
Rich Steel Products Co. - - - - - - - - - - *Los Angeles*
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Street Lighting and Equipment Co. - - - - - *San Francisco*
United Casting Co. - - - - - - - - - - - - *Los Angeles*
U. S. Cast Iron Pipe and Foundry Co. - - - - - *L. A.-S. F.*
Wailes-Dove Hermiston Corp. - - - - - - - *San Francisco*
Wallace and Tiernan Co. - - - - - - - - *San Francisco*
Water Works Supply Co. - - - - - - - - - - *L. A.-S. F.*
Western Concrete Pipe Co. - - - - - - - - *Los Angeles*
Western Construction News - - - - - - - *San Francisco*
Western Pipe and Steel Co. - - - - - - - - - *L. A.-S. F.*
Western Well Works - - - - - - - - - - - *San Jose*
Worthington Meter Co. - - - - - - - - - - *L. A.-S. F.*

Supervising Water Supplies

(Continued from Page 62)

gaged very little attention among waterworks men in California, and this may be the main reason why so little headway has been made in getting rid of dual supplies. Instead, waterworks men have been inclined to leave the responsibility to the health departments. Knowing well how both sets of officers function and the staff limitations of most health departments, however, I believe that to get results it is essential to work out some harmonious procedure which the waterworks men themselves can feel free to pursue, even though it consumes considerable time and patience. Heretofore the attitude toward cross connections has been so arbitrary that it generally invited ill will, and that is entirely foreign in the public relations of waterworks departments. A dogmatic campaign against cross connections is not in my opinion the best formula to get results in most hands.

No General Procedure

Each case must be viewed in a broad, impartial way. I doubt that any general procedure can be worked out that will not be arbitrary and hence defeat its own end. If there are ordinances covering cross connections, they had best be enforced in a sympathetic way. If it is a fact that the reason for the cross connection practice is an inadequate pressure, the remedy is of course more supply or rectification of distribution. Better fire protection and lower insurance rates are more universally understood than the mysteries of pollution. There are few who do not need to be shown what pollution is and just how polluted dual supplies get into drinking water.

I understand that most of the fire underwriters do not allow reductions in rates where the dual supply is a dangerous one. This of course is an important policy discouraging many cases. In most cases it costs a good deal to eliminate a cross connection. On the other hand, we have more or less danger to the public health in cross connections, but obviously it should be evaluated and balanced against whatever advantages there are in each cross connection. If there is a menace, certainly the premises where the cross connection exists, being closest to the polluted supply, takes the greatest risk.

Every waterworks man knows how little he is influenced by opinions on the degree of pollution represented to him and how much more by tests and proof. The same considerations apply when one seeks to eliminate a cross connection. If a convincing argument cannot be put up to get rid of a cross connection it is better to find some further bolstering evidence and couple it with an appeal to the self-interest of those who have the cross connection.

Cross Connections Should Be Eliminated

I question if it is not somewhat unreasonable to summarily disallow double check valves under all circumstances and especially where complete elimination of the cross connection is clearly burdensome and the hazard vague and infrequent. When convincing evidence can be produced that a given double valve is not apt to be sufficiently dependable it should then be easy to win a better solution.

This program is quite opposed to a policing one. It involves considerable time, skill and patience. It calls for a technical and sympathetic understanding of cross connections in a broad way; gradual education and advertisement of the true menace in cross connections; attack upon the cases where the danger in the cross connection is least subject to dispute; but such a program can be safely and easily pursued by the water departments themselves. Certainly if they will undertake this problem under this program or some other, the elimination of cross connections will be most quickly accomplished.

Concrete Pipe for Sewage Disposal Systems

(Continued from Page 45)

other communities. Through the formation of such a district each city and town, whether incorporated or not can proceed under existing laws to build its own lateral sewers to serve residence and business property.

Reinforced concrete pipe is playing an important part in these new outfall sewer systems. Many miles of pipe, ranging in size from 24 to 60 inches in diameter, have already been laid. Because the sewers are often placed deep in water-bearing ground, reinforced concrete is particularly adapted for their construction. Being factory made, the best possible results are obtained in the concrete and adequate reinforcing steel is used to give the pipe ample strength to meet all conditions encountered.

In the great storm drain systems being installed by Los Angeles County, and other Southern California counties and cities, reinforced concrete pipe also plays a prominent part. In addition to its great strength and reliable performance, it can be installed with a minimum interference to traffic. There are five firms in Los Angeles and vicnity now supplying reinforced concrete pipe for projects such as the above.

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LEGAL *and* JUDICIAL

A DEPARTMENT CONDUCTED BY HANKINS & HANKINS

Failure to Repair Ditch Does Not Forfeit Right to Water

An attempt of the trial court to apportion water according to the intent of the parties upheld.

In the case of Hand et al. vs Cleese et al 74 Cal., Dec. 259 (Aug. 29th, 1927) the Supreme Court sustained the finding of the trial court interpreting the effect of a term of an agreement concerning water rights, as follows:

"The uncertainty of the agreement between the parties presented difficulties to the trial court in the division of the water, and these difficulties were recognized by the court. While the agreement granted to Maxwell 'the free use of water from said ditch for the purposes of irrigation and agriculture only,' it is perfectly clear from the terms of the agreement and from the surrounding facts and circumstances that Johnson intended to retain the use of a considerable portion of the water for himself for mining and domestic purposes, . . . The trial court, considering all these facts and circumstances, concluded that the intention was to divide the water equally. This seems a fair construction of the instrument . . . and in the absence of exact information on the question the court could do no better than to follow the maxim that equality is equity."

The appellant also claimed that the plaintiff had lost the right to claim any portion of the water by reason of his failure to do his share in maintaining the ditch as agreed upon. On this point the Court says:

"Upon this question we are in accord with the trial court that such failure to repair would merely give rise to a suit to recover one-half of the amount expended by defendants in repairs. Equity abhors a forfeiture and, in the absence of a positive rule of law attaching such a penalty in a case like the present, the courts will not enforce so drastica remedy." (Citing 132 Cal. 178.)

Riparian Rights Once Again Sustained by Supreme Court

Law as interpreted in Lux vs. Haggin declared to be still the law of California.

In the case of Fall River Valley Irrigation District vs. Mt. Shasta Power Corporation, 74 cal. Dec 275 (Sept. 1st, 1927), the Power Company take the reverse position of the one occupied by the Southern California Edison Company in the celebrated Herminghaus case. In the Fall River Valley Distri case the Power Company recognizes and adopts the riparian theory, and to pr tect itself, buys up all the riparian land on Fall and Pitt Rivers (tributaries of the Sacramento River) between its point of diversion and point of use for power purposes. The Irrigation District desires to appropriate water above the Power Company diversion, for irrigation purposes, which is objected to by the company. The district's rights were based upon permits issued by the Water Commission.

In upholding the claims of the Power Company the Supreme Court re-asserts its position taken in the Herminghaus case and declares that a riparian right on a non-navigable stream is a vested property right inhering in and a part and parcel of the abutting lands, a right qualified only by the correlative rights of other riparian proprietors, to use the entire ordinary and natural flow of a stream for all lawful riparian uses and also to have all such flow come down to the land undiminished other than by the lawful uses of upper riparian proprietors or by the rights of those who have otherwise obtained a superior claim to the use of a portion of the stream.

The Court again reviews the decisions of the State upon the Riparian doctrine from the early case of Lux vs. Haggin, 62 Cal. 255 (1882) to date.

Section eleven of the Water Commission act was declared inoperative in so far as the rights of riparian owners are concerned, but was not found to be unconstitutional. In upholding the riparian theory this case is even stronger in its language than the Herminghaus case (73 Cal. Dec. 1), and Judge Preston writing the decision states:

"At no time has there been any uncertainty as to the ingredients, quality or strength of the (riparian) right. On the faith of the doctrine practically all valuable land titles in this state have passed into private ownership. . . ."

In reference to the Police power of the State under which Section 11 of the Water Commission act was claimed to operate, the Court states:

"We need here only say that the legislature department of the State may not take any portion of a vested property right from one person and invest another with it and be justified in so doing in view of the provisions of Sections 13 and 14 of Article I of the State Constitution and the Fourteenth Amendment of the Constitution of the United States."

Rules of Riparian Rights Reviewed by Supreme Court

Doctrine of balance of conveniences declared not applicable as between riparian owners.

In the case of Scott et al. vs. Fruit Growers etc., et al., 74 Cal. Dec. 266 (Aug. 29, 1927), the Supreme Court of California reviews many rules of Riparian rights.

For many years a certain spring, flowing considerable water, and with its source on defendants' land, had been used by defendants and also by various users lower down on a stream created by the spring. In 1924, the defendants constructed a concrete dam and diverted the water to other lands not riparian and for other uses. Lower riparian owners bring an injunction proceeding to prevent such diversion. In upholding the injunction issued by the trial court the Supreme Court quotes the following rules of law:

Two theories are advanced by appellant for a reversal of this judgment. The contention is made that as an upper riparian proprietor, it was entitled to divert the waters from the riparian lands to the mill pond. This position is clearly untenable. "A riparian proprietor on whose land a stream rises has no more right than other riparian proprietors. . . ."

The other contention is that a right to the water of the spring has been acquired by appellant by prescription. This contention is answered by the evidence . . . to the effect that the appeallants in irrigating the Long Ranch, merely diminished the waters . . . for a period of from 24 to 48 hours, and thereafter the water returned to the creek for the use and benefit of the lower riparian owners. The presumption is that in the use of water an upper riparian proprietor is exercising his riparian rights, and no title by prescription can be given unless it is brought home to the lower riparian proprietors that the upper riparian proprietors asserts a right other than his riparian right. . . .

It is also true that even though the appellant had acquired a prescriptive right to irrigate the Long Ranch with the entire flow of Bagwell Springs, it would not have an incidental right to use the water on land other than that for which the prescriptive right was acquired . . . where such diversion resulted in injury to others . . . since the prescriptive right is limited by the extent of the use which conferred the title, the place of use cannot be changed, where to do so would interfere with the rights of others . . .

Appellant contends for a doctrine which has been designated "the balance of con-

venience," and urges that as its needs are very great for this water and its investment very large, those circumstances should weigh against the plaintiffs' rights, which have reference only to small pieces of land of comparatively little value. Such argument has no place in the law governing riparian rights. . . .

It is not the purpose of this action and it is not the effect of this judgment to deprive defendant and appellant of the use of the waters of the springs for irrigation of the Long Ranch, but merely to enjoin it from diverting the waters from the watershed, and it is settled that even an appropriator of water may not change the point of diversion to the injury of others. . . .

Riparian proprietors may restrain the taking of water to non-riparian land without showing damage. . . .

Automatic Control at Diversion Dam of Ditch Company

All water diverted from the Truckee River is under the direction of Federal Water Master, Harry Dukes, acting under a decree of the Federal Court, and as there are a number of diversion dams for irrigation and other purposes along the river, keeping them regulated requires the constant attention of the Federal forces. However, modern labor-saving devices help to simplify the work as will be shown in the following described installation:

Calco automatic radial gate installed at the diversion dam of the Orr Ditch Company. (Left) J. Rajetto, Superintendent Orr Ditch Company (right) W. L. Edwards, Assistant Federal Water Master.

The Orr Ditch Company divert a head of 90 second feet from the Truckee River, five miles west of Reno, Nevada, for the irrigation of some 3,500 acres. Here is installed a 48 inch by 48 inch Calco automatic radial gate used as a spillway control, regulating the head over a ten-foot measuring weir placed across the ditch, immediately below the spillway. This gate regulates the flow down the ditch without the necessity of a headgate tender at the diversion dam.

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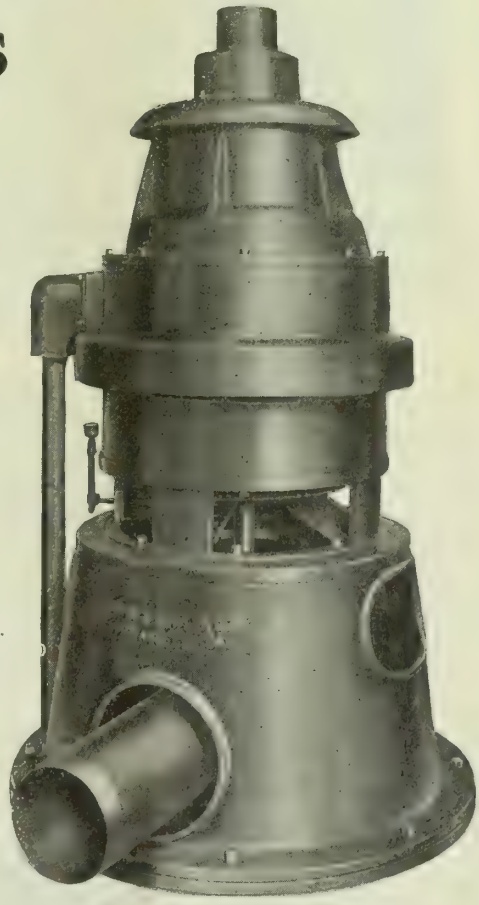

Layne & Bowler Pumps reflect the closest approach to perfection. The precision with which each part is finished and the nicety of design are suggestive of the care taken in making quality an integral factor. Experience to the extent of 42 years of specialization in pump building is a contributing factor to their durability.

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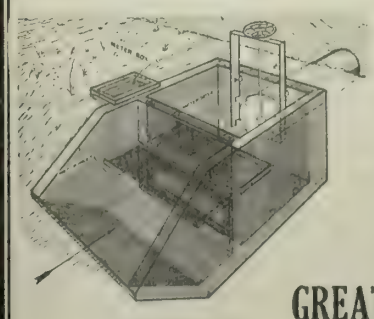

Submerged Orifice Measuring Structure

acre foot meter and turn out gate combined.

The installation cost of this unit is remarkably low. Write for design catalog.

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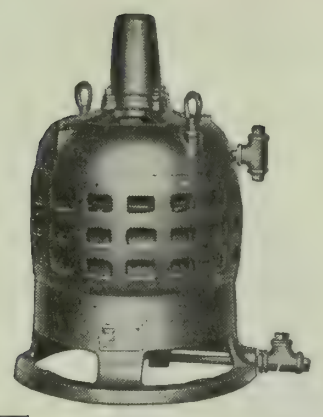

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A MOTOR that removes motor uncertainties from deep-well pumping. **Ball-bearing!** Built by the pioneer manufacturers of the first complete line of **ball-bearing** motors. Built specifically for driving deep-well pumps and used as standard equipment on this type of pump by many leading irrigation pump manufacturers.

This type of Deep-Well Vertical Motor has a specially designed hollow shaft into which the pump shaft is fitted. The construction assures perfect alignment of motor shaft and pump shaft. The famous F-M **ball-bearing** construction provides easier running and increased dependability. Ball-bearings absorb all thrust as well as radial loads, lengthening the life of both pump and motor.

Note the compactness and low mounting of motor. Here, obviously, is a motor well adapted to irrigation requirements. Ask for special bulletin giving full details on the F-M Hollow Shaft Vertical Motor. Address nearest branch.

The Fairbanks-Morse line covers practically all types of motors for pumping, including single and double-wound squirrel-cage types in both solid and hollow-shaft motors. Write for free bulletins, specifying type of service required.

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Pumping Equipment for Irrigation Service

AEPA 2-20

Large Irrigation Project Planned for Northwest

(*Continued from Page 17*)

Yakima and Boise valleys, alfalfa predominating, but with grain, fruit, potatoes and other truck crops in substantial quantities, and live stock and dairying products. The chief market would be the cities of the Pacific Northwest and Pacific slope but certain crops, such as dairy and poultry products and some of the high grade fruit and vegetables could be shipped by rail or water to the eastern part of the country and exported. The project is well served as regards transportation, being traversed or touched by five transcontinental railroads with several branches.

Available Water Supply

Water required for the maximum irrigation development would be 5,684,000 acre feet. The mean annual run off of the Pend Oreille or Clarks Fork River at the point of diversion is 18,967,000 acre feet and the minimum run off at the point of diversion is 11,000,000 acre feet. Careful consideration of all probable stream depletion above the point of diversion indicates a surplus of water for the Columbia Basin Project with no storage essential under the pumping plan but with some one or two million acre feet of storage required for the gravity project, depending upon its size, as finally determined.

Present Status of Project

The project has been approved officially as feasible by the Department of Conservation and Development of the State of Washington and by the Federal Columbia Basin Commission in its report to the Secretary of the Interior of August 25th, 1925, reviewing the reports of various engineers, from which the following is quoted:

"This report agrees with previous reports in regarding the project physically feasible; the land is fertile, the water supply adequate, and climatic conditions make possible large yields of general farm crops and a variety of orchard and garden products."

With this finding as to general feasibility of the project, other pertinent questions arise and are now under investigation as follows

As the Columbia River is an interstate stream, it is obvious that one of the first steps, looking toward construction of this project, is to reach an agreement between the states as to an equitable division of the waters of the stream. Congress and the legislatures of the four interested states have authorized the drafting of a compact for division of the water among the four states, and negotiations, looking to such a compact, have been under way for more than two years.

Negotiations thus far have shown that the problems most difficult of solution have to do, not with actual division of the water, but rather with limitations of the use of storage reservoirs in the upper states, necessary or desirable in connection with development in the lower states.

It has been agreed by members of the Allocation Board that there is ample water to serve all prospective use in all of the states and some progress has been made, looking toward a comprehensive development program for the entire stream, in the support of which all of the states can heartily join.

In connection with the pumping plan of the Columbia Basin Project, a large amount of auxiliary hydroelectric power could be developed. Studies are now being made by engineers of Washington State Department of Conservation and Development to determine the amount of auxiliary power that might be developed in connection with both the pumping and gravity projects, having in mind that the sale of excess power might be used in part to reduce irrigation costs.

Economic and Market Surveys

The Department of the Interior, through the Bureau of Reclamation, is making an economic survey of five typical blocks of land within the project, with a view to determining present and possible future production, feasible size for farm units, the most desirable and profitable crops to be grown under irrigation, the attitude of land owners, etc.

The State Department of Conservation and Development, through the Washington State College, is having made a market survey for the purpose of determining as nearly as may be, the growth of markets for such crops as would probably be produced in the Columbia Basin roject. This will cover the actual increase in markets accessible to the district during the past twenty-five years and prospective increase in the next twenty-five or thirty years, estimated on the growth of population, manufactures, commerce, etc. Consideration will be given to world markets for staple crops, also to freight rates on staples and special crops and other factors likely to have a bearing on the outlet for the products of the Columbia Basin.

Ultimate Development of Project

Investigation by the State of Washington of this great irrigation project and the auxiliary hydro-electric power that may be developed in connection with it, has stimulated interest in the other states and more consideration is being given than ever before to the immense potential value of the Columbia River to every state and community it touches.

This stream and its larger tributaries have possibilities for irrigation and power development in almost every county. Occasional floods are a serious menace in a few locations, such as Flathead Lake in Montana, along the Kootenai River and Pend Oreille Lake and River in Northern Idaho and Washington and on the lower river in the vicinity of Portland and it may be that some day the dreams of the pioneers may come true and that for hundreds of miles this mighty river may become an important artery of commerce.

Engineers are studying these possibilities and it is to be expected that from their studies will result a comprehensive plan for utilization of this great resource of the Northwest, a plan toward the consummation of which the four states, Oregon, Washington, Idaho and Montana, will work together for the common good.

Waterworks Convention at San Jose, October 5 to 8

(Continued from Page 33)

Vendome; and on Saturday morning there will be a trip to San Jose watersheds with luncheon by the San Jose Water Company.

The officers and committees of the California Section of the association are as follows:

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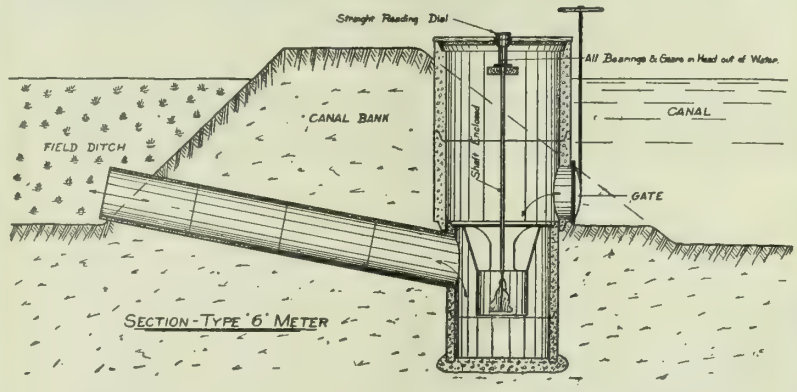

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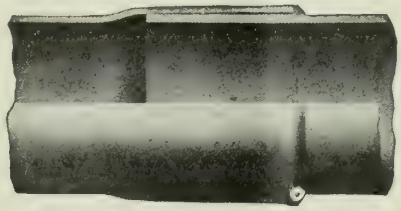

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It will resist the greatest hydrostatic pressures and has the greatest resistance against corrosion, chemical action and adverse soil and climatic conditions.

"Astco" Seamless Steel Line Pipe is supplied in all diameters and lengths averaging 40-ft. Ample stocks for immediate deliveries. Write for stock list, specifications and prices.

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OVERHEAD IRRIGATION

PUMPING PLANTS FOR OVERHEAD SYSTEMS

By S. M. FORTIER

THERE are four factors that must be considered when designing a pumping plant for spray irrigation systems. These may be classified as follows: the amount of water to be pumped per minute; the static head or vertical distance between the level of the water supply and the highest nozzle; the friction and velocity heads, or the total resistance to the water passing through the pipe lines; and the pressure head, or the amount of pressure necessary to operate the nozzles.

The capacity of the pumping plant should be the same as that of the feeder system. The static head can be determined by means of a survey in the field with an engineer's level and due allowances made for the distances the water may be lowered when pumping, as well as the height of the nozzles above the ground. The frictional and velocity heads can be obtained from the hydraulic tables when the kind, size, and length of pipe, and the amount of water are known.

Knowing the capacity and the sum of the heads, the amount of work which the plant must perform is determined and the horsepower can be calculated to correspond to the guaranteed efficiency of the pump to be used.

Determining the Pump

The most desirable type of pump to be used in any one case must be determined by the above factors and any restricting conditions of the water supply, such as deep well, water containing sediment, etc. All factors and conditions should be furnished to several manufacturers so that they can bid on their most adaptable machinery, and the irrigator obtain the most efficient equipment for the expenditure.

Power displacement pumps of the piston displacement types, and high pressure centrifugal pumps are the designs commonly used for overhead irrigation plants.

The single cylinder displacement pumps are adaptable to small plants up to 75 gallons per minute, where water is within 25 feet of the pump. This type is sometimes the only one advisable to use in deep wells for any quantity of water. The piston should be double acting and lift water when moving in either direction. The pump should be equipped with a large air chamber which will act as a cushion and reduce pulsation of the water to a minimum. The power head and cylinder are built in a compact unit for low suction lifts but must be separated for deep well use. In the latter case it is best to have the cylinder always under water if possible.

Centrifugal Pumps

Centrifugal pumps can be used to advantage for overhead irrigation under some conditions. Large centrifugal pumps are more efficient than small ones. Centrifugal pumps also decrease in efficiency as the head against which they must work increases. Therefore, the larger the plant and the lower the lift the more adaptable is the centrifugal pump. Where the total head does not exceed 100 feet a single-stage high pressure pump may be used. These pumps should be built for high speed with long bearings and adequate oiling facilities. Two-stage centrifugal pumps should be used for heads between 100 and 250 feet as they can be run at lower speed than the single-stage for like heads.

The efficiency of a centrifugal pump may not be as high as the beginning as a good displacement pump but unless the displacement is kept in the best of repairs its efficiency is apt to drop below that of the centrifugal pump which maintains its efficiency under long wear.

John R. Mudge, Western representative for the Badger Meter Manufacturing Company, returned to his office in Los Angeles the latter part of September after a trip to Phoenix and other points in Arizona.

San Jose Water Supply Derived from Deep Wells

(*Continued from Page 24*)

pany. The workmanship and materials, and field installation as well, were found perfectly satisfactory in every way.

The estimated population of San Jose and vicinity is 70,000; Los Gatos and vicinity 6,100; Saratoga and vicinity 1,100. We thus serve a population close to 80,000. The system includes 288 miles of pipe.

The annual consumption of water is approximately 2,400,000,000 gallons; the daily consumption is 5,000,000 gallons in the winter to 10,000,000 gallons in the summer time. The daily per capita consumption is 90 gallons.

Skagit Project Plans New Dam

The city council of Seattle, Washington, at a recent meeting voted to speed construction of a masonry dam across the Diablo Canyon on the Skagit River. At the same time the council utilities committee unanimously approved a bill providing $50,000 for preparation of plans for an Ambursen dam near Gorge Creek. It was originally the council's intention, it is said, to complete a dam and a powerhouse at Diablo Canyon and possibly another at Ruby Creek, farther upstream, before returning to develop the Gorge Creek plant but the utilities committee reports that immediate increase in power production is the greatest need of the light department.

Water Firms Plan Combine

Three companies organized to supply water to ranchers in the Orange Heights, Villa Park and El Modeno districts, Orange County, California, are proposing to unite in one large organization serving 1450 acres, according to a recent announcement. It is pointed out that the three companies as now organized have overhead expenses which, if the companies were combined, would be materially reduced.

Mokelumne River Project Pumping Plants

(*Continued from Page 54*)

no appreciable pressure rise or shock will be created in the pipeline. A solenoid-operated valve is supplied with each check valve, the operation of which will effect a closure of the check valve in the event of failure of the electrical circuit and stopping of the pump motor.

In addition there is also furnished with each valve, auxiliary hand control for opening or closing the valve together with an hydraulic cylinder which also performs these operations, both being external to the body and therefore unaffected by a differential in pipeline pressures. The hand control is used principally at such times as the pumps are started, the valve being opened gradually to prevent vacuum adjacent to the pumps on the suction side. The rate at which the check valve may be opened after the pumps are started is determined from a reading of pressure gauges at the inlet to the pumps.

As a safeguard to the eighty-three miles of pipeline and to prevent damage to the highly cultivated districts through which the line passes in the event of a break in the line, the district engineers have installed four specially designed automatic synchronous stop and discharge valve units, each consisting of an interconnected electric motor-operated butterfly valve and relief valve. They are located at points on the aqueduct where an emergency drainage of the line will not damage the surrounding country. Should a break occur, the increased velocity of the water due to discharge from the rupture automatically starts the electric motor, closing the butterfly valve and opening the relief valve nearest the break on the upstream side. Should there be a reversal of flow on the downstream side of the break the butterfly-relief valve mechanism nearest the break on the downstream side operates in a similar manner. In this way a minimum amount of water will be lost from storage and every possible protection from further breaks or collapse is given the pipeline under these emergency conditions.

From storage reservoir to the point of distribution in Oakland, the Mokelumne water supply project comprises a series of engineering problems, all of which have been most carefully worked out not only with a view to maximum safety and economy but with every consideration for future requirements of the East Bay District. Many legal obstacles have been met and overcome and in the main the project has been carried on in accordance with the schedule as originally laid out.

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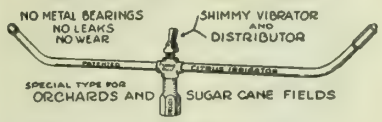

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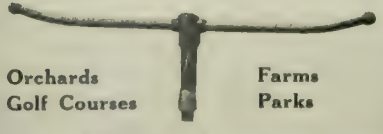

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If the water recedes 18 feet *just add at the top* 3 six foot sections and there is your water. No waste time — no loss of water—no changing of speed. No removing the pump—in a few hours you have your full flow of water.

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5"	wells give up to	300 gallons
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Write Us Your Problems

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ADDRESS.....

FRANK J. KIMBALL CO.

P. O. Box 27, Station K,
Los Angeles, California

Chlorinating Sulphur Water

(*Continued from Page 64*)

An ortho-tolidin test showed very heavy residual chlorine early in the morning but by noon this was reduced to 1 or 2 p.p.m. of free Cl entering the pumping main. No complaints were received from excess chlorine and an improvement in taste and odor were again noted near the plant, except the first thing in the morning when at times for a short while the trouble would be even worse.

In spite of the heavy dose of Cl, no o-t reaction was observed for over a week along the pumping line further away than two blocks. It was nearly three weeks before free Cl was observed eight blocks from the point of application.

This transmission line was 16-inch riveted steel pipe less than three years old and about 7,700 feet to a water tower riding on the line. Ties to the distribution system were made about every block. From this tower the water was boosted another 8,000 feet to a reservoir riding on the line, the distribution system being tied in as before. Free chlorine was observed at the tower in about a month after first starting the new machines. During this time the machines were operated to their full capacity as long as water was pumped.

Organic Matter in Pipe Lines

The cause of this unusual consumption of chlorine is attributed to the very heavy coating of beggiatoa and other organic matter on the interior of the pipe. In places where the pipe was opened, this coating was found to be an eighth-inch or more in thickness. The increased odor observed in some places early in the morning was due to the large amount of organic matter killed off by the chlorine and decomposing over night, there being insufficient chlorine present to prevent this. Allowing the house fixtures to run for a few minutes each morning usually cleared this up and no further trouble would be encountered for the rest of the day.

Complaints due to excess chlorine were very few at first and about equally divided between those who confused the taste with H_2S and reported it as such, and those who ascribed it to "clorox" but admitted it was "Better than that old sulphur taste." Later, as the mains became cleared of their organic coating, the chlorine became more objectionable, but the black water and early morning odors were proportionately reduced.

During all of this time, over two months, a dose of 80 lbs. per million gallons was used. The residual chlorine ranged from about 2 p.p.m. near the plant to nothing a mile away. For the most part the consumers were quite patient, and while registering complaints, were always ready to speak well of improved conditions and relief from the black water trouble.

Chlorination has been kept up for the past year using all the chlorine possible without danger of an uprising of the consumers. The dose has been steadily reduced until now about 40 lbs. per million gallons will give a residual of 0.5 p.p.m. at the pumps.

Chlorination Successful

During the winter any change in chlorine dose was readily noticed at points quite distant from the transmission line, showing that the organic coating had been practically removed from the pipes. This was also checked by digging up and cutting sections of pipe at several points in both transmission and distribution systems, where heavy growths had previously been observed. The sections were now found to be quite clean and free from anything but an occasional tubercle due to the usual pipe corrosion.

This summer, 1927, has been fairly free from complaints of odor or black water. The few reported have been from outlying sections or due to work on mains jarring sediment loose. Bacterial tests have failed so far to show the presence of any sulfide formers.

The method of chlorination for treatment of a sulfide water is expensive, but as an emergency measure it has been considered successful. For permanent treatment filtration and lime softening are proposed, and the construction of a plant of this type will start some time in October.

New Process Steel Pipe

(*Continued from Page 61*)

any seams, therefore, there is no seam to burst. Each individual pipe is tested up to 1800 pounds per square inch, and the bursting pressure of Astco seamless steel pipes of standard thickness is between 6000 and 7000 lbs. per square inch. This makes it impossible for an Astco pipe to burst, as such pressures cannot occur in service.

A further feature of Astco pipes is their long lengths. They are manufactured in random lengths up to 45 feet. This is a great advantage, as in the first place the number of joints is considerably reduced, which lessens the danger of leakage, and also a large saving is made in laying costs.

John Stauffer, Jr., manager of the Stauffer Chemical Company, Los Angeles, spent the greater part of September at the company's main office in San Francisco.

Design and Construction of Bull Run Dam

(Continued from Page 15)

supply area. Isolated camps of the clearing contractor are equipped with incinerators. Periodical tests of the water at the city intake are made for B Coli and an emergency chlorinator is on hand for immediate service when advisable. All sanitation is under the control of the city and state Boards of Health.

In regard to cost it may be stated that the road to the dam to connect with previously existing roads is heavily macadamized and well drained and cost about $200,000. The clearing contract for $171,000 covers 434 acres and was placed with Heller & Co. in November, 1926. The contract for dam construction was let for $1,450,000 to Bent Bros. in February, 1927, who during the spring and summer built about 3 miles of railroad for the haul of gravel, erected gravel screening, washing and mixing plant, with 300 feet double steel spouting tower, cleaned foundation across the river and about 75 feet up the hillside and started placing concrete in early August. The price received by the contractor for plain concrete in the dam is $4.30 per cubic yard, the cement being furnished by the city at nearest rail road point.

Source of Material

Contract was placed for 3 36-inch needle valves and 3 48-inch butterfly valves with the Pelton Water Wheel Co. for $17,500, for 2 66-inch and 2 90-inch butterfly valves with Joshua Hendy Co. for $24,300 and for the sluice gates with the Coffen Valve Co. for $10,400, all f.o.b. Bull Run. The 4 5-foot by 8-foot automatic butterfly gates in the gate tower are purchased from the Willamette Iron & Steel Co. for $6,900.00.

Cement is bought from the Santa Cruz Portland Cement Co. for $2.37 per barrel net, f.o.b. Bull Run station 25 miles from Portland.

The total estimated cost of all work is now figured at $3,000,000.

The work is carried on by the City Water Department, John M. Mann, City Commissioner, under the general supervision of Ben S. Morrow, Chief Engineer of the Water Department with Ben A. Torpen in immediate charge of the work, the writer acting as Consulting Engineer.

J. C. Albers, city engineer of Beverly Hills, California, was elected president of the League of California Municipalities for the coming year at the convention held in Sacramento recently.

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SURVEY *of* HYDRAULIC DEVELOPMENT

A summary outline of developments contemplated on Western projects which have been announced during the month

Filtration and Chlorination

SANTA MARIA, CALIF.—The city has voted a $65,000 bond issue for the purpose of installing a soft water system to the present water supply.

ROSEVILLE, CALIF.—The cause of the recent typhoid epidemic has been definitely traced to the water supplies of the city, according to reports issued by the State Board of Health.

BRIDGER, MONT.—Plans are being formulated for the construction of a settling basin of 300,000 gallons capacity, a concrete pump house, a low lift pump, and additional high lift pumping equipment. The work is under the direction of the Pillsbury Company of Minneapolis.

Irrigation Development

OROSI, CALIF.—A special election has been held, authorizing the issuance of $2,300,000 in bonds to complete the irrigation project of the Foothill Irrigation District. This district comprises 50,000 acres lying east of the Alta Canal and west of the foothills from Oakhurst on the north and Madcap on the south. H. J. McKenzie of Orange Cove is president.

Reservoirs and Dams

DURANGO, COLO.—Construction upon the Haviland Dam is rapidly progressing, according to reports. W. H. Wigglesworth is consulting engineer.

FRESNO, CALIF.—San Joaquin Light & Power Corp. has started construction of a $200,000 afterbay dam below the Balch power house on Kings River. It will be 170 ft. in length at the crest and 75 ft. in height. About 7000 cu. yds. concr. will be used.

SANTA BARBARA, CALIF.—The city council has voted to call a bond election for the purpose of issuing $350,000 in bonds for the purpose of constructing additions to the present Sheffield reservoir. The council stated that it is imperative that the city have a large reserve supply near the city for emergency use.

WHITE BLUFFS, WASH.—It is rumored that a large new dam will be constructed near White Bluffs, known as the Priest Rapids Dam. This structure will be primarily for power development, and it is said that the DuPont interests are behind the project. Water will also be diverted for irrigation uses, in conjunction with the power development.

SEATTLE, WASH.—Plans for the $2,500,000 power project of the city have been presented to the city council by Superintendent J. D. Ross. (See June MODERN IRRIGATION.) The amount of money asked for at this time is for the construction of the Diablo Dam, which will add 50,000 horsepower to the present power supply.

LOS ANGELES, CALIF.—The County Flood Control District has completed plans for the new dam to be erected in Dalton Canyon. This contemplated structure will be 165 feet high, and 500 feet long. Original plans called for a dirt fill dam, which has been partially completed, but this structure will be abandoned in favor of the new, which will be located about 400 feet above the site of the dirt fill dam.

LOS ANGELES, CALIF.—County flood control department will probably start work in the near future on the Tujunga Dam, one of the projects proposed under the county flood control program. The county has available $1,600,000 and the city water department will pay the balance up to $3,000,000, which is the estimated cost. Roy Dowds, county flood control counsel, has announced that negotiations for water rights necessary to the dam are under way.

LOS ANGELES, CALIF. (San Gabriel Dam)—Plans for a high dam at the San Gabriel Dam Site are practically ready for submission to the consulting board of engineers, members of which are D. C. Henny of Seattle, J. B. Lippincott of Los Angeles, and J. W. Reagan. The high dam is to be 425 ft. high, 2200 ft. in length, and 421 ft. thick at the base and 30 ft. at the top. E. C. Eaton, 202 N. Broadway, is chief engineer of the county flood control district, and will have general supervision of the letting of contracts and construction of the project.

Reclamation and Drainage

IMPERIAL, CALIF.—The Imperial Irrigation District plans the raising of the levees along the lower twelve miles of the Colorado, according to a report given out by M. J. Dowd. The tops of the present levees will be elevated from one to four feet, at an estimated cost of $80,000.

RIVERSIDE, CALIF.—The organization of a storm drain district is being contemplated by valley residents. Mayor Jarvis appointed a committee last May to investigate the necessity of such a development, and according to a recent report, they advocate such an organization. It is estimated that the drain will cost about $360,000.

SANTA ANA, CALIF.—Paul Bailey, former state engineer, has been appointed to the office of county flood control engineer to superintend the construction of the Prado Dam and other work included in the Orange County flood control district program for which a $6,000,000 bond issue is planned. The proposed dam is to be an earthen dam and will be built on the Santa Ana River at Prado, a few miles east of Ontario. Bailey has been recently engaged in a survey of the watersheds of San Bernardino, Orange, and Riverside counties.

LOS ANGELES, CALIF.—Resolution of intention has been adopted by county supervisors for the construction of a drainage system in Drainage Improvement District No. 21, covering the Montebello district, along Whittier Blvd., in the general vicinity of the new Goodrich Rubber Co.'s plant. Area drained will be 713 acres. Plans and specifications have been prepared under the direction of C. E. Arnold, drainage construction engineer, 7th floor, Hall of Records. Hearing will be held Sept. 6. Approximate quantities are: (1) 45 No. 1, 7 No. 2, and 2 No. 3 catch basins; (2) 42 No. 1 w/a, 10 No. 2 w/a, 4 No. 3 w/a, and 3 No. 4 w/a catch basins with aprons; (3) 3 No. 1 manholes, 38 No. 2 manholes; (4) one No. 1 jct. struc.; (5) one No. 1 and one No. 2 special jct. struc.; (6) one main trunk special outlet struc.; (7) reinf. concr. pipe: 788 ft. 21-in. H, 174 ft. 24-in. M, 1471.71 ft. 24-in. H, 398 ft. 27-in. M, 1622.29 ft. 27-in. H, 543.50 ft. 30-in. L, 514.06 ft. 30-in. M, 351.51 ft. 33-in. L, 347 ft. 33-in. M, 3332.34 ft. 36-in. L, 2275.45 ft. 39-in. L, 101 ft. 39-in. H, 631.76 ft. 42-in. L, 1192.83 ft. 45-in. L, 1494.68 ft. 48-in. L, 400.86 ft. 51-in. L, 868.40 ft. 54-in. L, 815.66 ft. 54-in. H, 726.01 ft. 57-in. L, 526.60 ft. 60-in. L, 299.04 ft. 63-in. L, 581.08 ft. 66-in. L, 1236.12 ft. 81-in. M, 1262.86 ft. 90-in. L, 275.55 ft. 90-in. H, 100 ft. 90-in. D. H.; (8) plain cement pipe: 2302.50 ft. 12-in., 1025 ft. 15-in., 238 ft. 18-in., and 70 ft. 21-in.; (9) 2620 sq. yds. decomposed granite surf.; (10) 28 sq. yds. 9-in. cement concr. surfacing; (11) 30,000 sq. ft. 2-in. asph. concr. surf. on 7-in. cem. concr. base paving. Estimated contract price, $234,965.09.

Sewage Disposal

BURBANK, CALIF.—Sept. 13 has been set as date for a $325,000 bond election for the proposed Los Angeles outfall sewer through Burbank. The sewer will be constructed by the city of Los Angeles. Work is to start at once if the bonds carry.

TUCSON, ARIZ.—Black & Veatch, Ferguson Bldg., Los Angeles, and Kansas City, Mo., have been retained by the city council as consulting engineers on the new sewage disposal plant to be built under the recent bond issue. The firm was retained on recommendation of City Engineer Geo. T. Grove.

VENTURA, CALIF.—The city trustees have asked the city engineer to prepare estimates for a proposed $200,000 sewer system for which a bond issue in the sum of $325,000 is to be placed before the voters within a few weeks. Included in the plans is the

enlarging of the trunk line from Casitas and the construction of a reservoir within the city limits. D. C. McMillan, city engineer.

SAN BERNARDINO, CALIF. — State health board has advised the immediate installation of a temporary sewer plant to protect the public health. Present conditions are declared a menace to the community. Currie Engineering Co., Alhambra, is designing a new system to cost $600,000, but temporary measures are imperative.

Waterworks

VENTURA, CALIF.—Sept. 13 has been set as date for $525,000 water and sewer system bond election.

SEATTLE, WASH.—A $300,000 project has recently been announced by the city, which contemplates the construction of a reservoir and a long 20-inch pipe line.

POMONA, CALIF.—City Engineer Froehde is about to build a 16-inch high pressure water main, through the main portion of the city.

CHEHALIS, WASH.—The city has sold the $80,000 utility bond issue, the proceeds from which will be used to improve the present water supply system.

PITTSBURG, CALIF.—City Manager Roy A. Watkins has recently presented plans for a new water system, estimated to cost $50,000. The contemplated improvements include a reservoir, and many water main extensions.

PE ELL, WASH.—W. J. Roberts, Tacoma engineer investigating the local water system, has rendered a report that the city needs additional water, and it is estimated that it will require $15,000 to accomplish the requirement.

PRESCOTT, ARIZ.—E. N. Brown Drilling Co., Phoenix, has been awarded the contract at a price not to exceed $10,000 for drilling a water well near the junction of Government Canyon, Slaughter House Canyon, and Granite Creek.

OCEANSIDE, CALIF.—Plans are being formulated for the construction of a large storage reservoir, and additional distribution mains for the city water supply system. At the present time a committee of the city Chamber of Commerce is investigating the feasibility of the project.

MONROVIA, CALIF.—Paul E. Kressly, H. W. Hellman Bldg., consulting engineer, has been appointed consulting engineer on the Huntington Drive improvement. Edward M. Lynch, Central Bldg., Los Angeles, has also been appointed consulting engineer on the White Oak Ave. improvement.

ABERDEEN, WASH.—The city council has voted acceptance upon the $1,600,000 bond issue for the construction of an industrial water plant upon the lower Wynooche River. The proposed plant will deliver 60,000,000 gallons of water daily by gravity flow to a point near Junction City.

MARTINEZ, CALIF.—It is rumored that the California Water Service, Inc., has a plan under consideration for the development of a gigantic water system which will bring water into Contra Costa County from a system of storage reservoirs, to be located in the foothills northeast of Napa. At the present time the cities along the Contra Costa bay shore are very much in need of additional water supplies, and if the rumor is true, it will meet with the hearty approval of the district affected.

Unit Bids

LOS ANGELES, CALIF. (Venice Outfall Sec. 2)—C. E. Green, 422 Western Mutual Life Bldg., submitted low bid to board of public works August 22 on Type 1 at $159,227.45, contractor to furnish materials, and at $109,580.81, city to furnish materials, for constructing Venice outfall sewer, Sec. 2. R. A. Wattson, 1026 N. McCadden Pl., Hollywood, submitted low bid on Type 2 at $172,700, contractor to furnish materials, and at $138,500, city to furnish materials. Thos. Kelly & Sons, Inc., submitted low bid on Type 3, contractor to furnish materials, at $171,125.99. C. E. Green was low bidder on Type 3, city to furnish materials at $114,507.44. The quantities were as follows:

TYPE 1.

(a) 5405 lin. ft. 3 ft.-9 in. semi-elliptical brick concrete sewer;
(b) 3492 lin. ft. 2 ft.-6 in. brick concrete sewer;
(c) 3543 lin. ft. 2 ft.-6 in. semi-elliptical brick concrete sewer.

TYPE 2.

(a) 5404 lin. ft. 3 ft.-6 in. semi-elliptical concrete sewer;
(b) 3492 lin. ft. 2 ft.-3 in. semi-elliptical concrete sewer;
(c) 3543 lin. ft. 2 ft.-3 in. semi-elliptical concrete sewer.

TYPE 3.

(a) 5404 lin. ft. 3 ft.-9 in. precast concrete pipe sewer;
(b) 3492 lin. ft. 2 ft.-6 in. precast concrete pipe sewer;
(c) 3543 lin. ft. 2 ft.-6 in. precast concrete pipe sewer.

Bids are as follows:

Martin Brkich—Type 1, Item A, contractor furnish materials, $162,120, city furnish materials, $116,186; Item B, contractor to furnish materials, $104,760, city furnish materials, $75,098; Item C (alternate), contractor furnish materials, $113,376, city furnish materials, $81,489; totals (alternate figure used where low in arriving at totals), contractor furnish materials, $266,880, city furnish materials, $191,284; Type 2, Item A, $162,120, $116,186; Type 2, Item B, $104,760, $75,098; Type 2, Item C, $113,376, $81,489; totals, $266,880, $191,284. Type 3, Item A, $148,610, $105,378; Type 3, Item B, $96,030, $67,594; Type 3 Item C, $106,290, $81,489; totals, $244,640, $172,972.

J. C. Duncan—1-A, $209,675.20, $169,145.20; 1-B, $135,489.60, $112,792.20; 1-C, $126,860.60, $107,374.10; totals, $336,535.80, $276,519.30. 2-A, $209,675.20, $169,145.20; 2-B, $135,489.60, $112,792.20; 2-C, $126,860.60, $107,374.10; totals, $336,535.80, $276,519.30; 3-A, $209,675.20, $169,145.20; 3-B, $135,489.60, $112,792.20; 3-C, $126,860.60, $107,374.10; totals, $336,535.80, $276,519.30.

C. E. Green—1-A, $99,438.55, $63,522.53; 1-B, $59,788.90, $46,058.28; 1-C, $61,434.23, $55,774.40; totals, $159,227.45, $109,580.81; 2-A, $142,108.68, $106,312.08; 2-B, $69,532.62, $55,263.95; 2-C, $71,784.25, $58,388.16; totals, $211,641.30, $161,576.03; 3-A, $118,567.39, $63,662.34; 3-B, $71,531.96, $53,154.39; 3-C, $70,114.64, $50,845.10; totals, $188,682.03, $114,507.44.

Thos. Kelly & Sons—bid on Type 3 only (contractor to furnish materials), A $109,781.41, B $61,344.58, C, $64,848; total, $171,125.99.

H. W. Rohl—bid on Type 3 only, A, $215,000, $190,000; B, $98,000, $88,000; C, $132,000, $120,000; totals, $313,000, $278,000.

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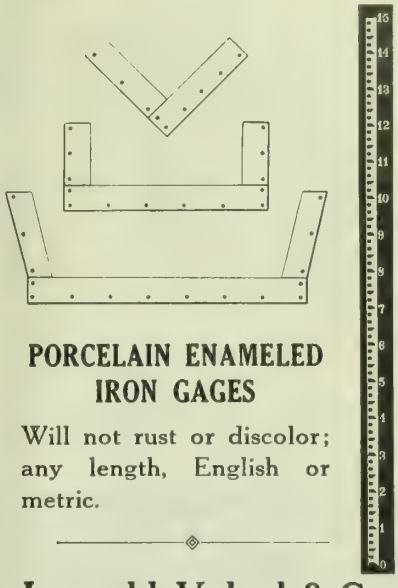

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Transmission and Delivery of Reservoir Water

(Continued from Page 21)

reasons therefor. The problem is an extremely complicated one, however, involving many variable quantities, so that even if much more money were expended and the investigation made comprehensive over a period of years there appears to be some doubt as to whether a transmission loss schedule can be evolved which will be absolutely equitable under all conditions to be encountered.

Losses Are Distributed

Meanwhile deliveries have been effected from year to year under what might be termed compromise schedules, based partially upon investigation or fact and in part upon mutual concession by the different classes or groups of users. Actual applied losses from Jackson Lake to Blackfoot have ranged from 5 per cent in some of the earlier years up to about 15 per cent with the average for recent years about 13 per cent. These are subdivided as follows:

From the outlet of Jackson Lake to Heise, Idaho (canyon section)—2½ per cent; from Heise to Lorenzo (so-called Snake River cone)—actual percentage loss each day as determined from the average of the two preceding days records with a minimum charge of 3 per cent; from Lorenzo to Woodville (section where a net gain in the river is usually noted)—½ per cent; from Woodville to Blackfoot (heavy loss section)—6 per cent.

Another troublesome item is the equitable segregation of stored water from normal flow at the outlets of the respective reservoirs. For Jackson and Henry's Lakes the practice of relying chiefly upon the reservoir capacity tables for determination of the amount of storage released daily has now been followed for a number of years. Special investigations indicated that while this method does not accurately apportion all the factors which make up the total outflow at all times and under all conditions, it is, in general, a reasonably fair plan of distribution and has the advantage of being easily operated. This method automatically credits the normal flow with all increments from bank storage return in lieu of the old natural lake storage and the extra water surface evaporation.

American Falls Reservoir

The situation at American Falls is somewhat different. Here there was no initial lake prior to the construction of the reservoir and little is known as yet concerning the relative values of such items as deep percolation loss and bank storage return, while the stored water will be subject to an evaporation loss charge for practically the entire exposed water surface. This reservoir is located in a section where the river previously showed a net gain from large springs and ground water sources. Data obtained by the U. S. Bureau of Reclamation during the summers of 1924, 1925 and 1926 suffice to determine that a little more than fifty per cent of this gain comes from surface streams which are measurable even under full reservoir conditions and that the total inflow or gain through the reservoir is quite consistent in its fluctuations with the changes noted in the measurable half. The normal flow which should pass the outlet gates can therefore be approximated by adding to the water of this character which enters the reservoir through the main river channel the product of the daily measured gain and the predetermined coefficient. This method is both laborious and expensive because it requires daily measurement and summation of the flow of about twenty-five rather inaccessible streams. Furthermore there is no assurance that a coefficient which was applicable in one year will also apply in another; but it affords a determination which is independent of evaporation, percolation, bank storage return and other such items, all of which are being studied during the present summer with the idea of evolving a simpler procedure for the future.

Jackson Lake Reservoir

The use of space in Jackson Lake Reservoir for the storage of decreed water rights and the later release and delivery of the water thus held back was authorized by mutual consent of all water users in 1924 and again on a more restricted basis in 1926. This plan encourages rotation use of water and undoubtedly helped to promote higher duty usage during these years when the total supply was deficient. Its adoption adds many complications to the work of water administration and because of the departure from normal procedure the plan is perhaps subject to attack on the question of damage.

The human relation feature of the water distribution work is probably more important than any other phase. It is often said that in an irrigated country an otherwise upright man will not hesitate in times of drouth to steal water and that the most peaceable citizen under ordinary conditions may quickly become one of the most violent if he thinks his water rights are being attacked or infringed upon in any way. Certainly, water disputes are easily started and sometimes become very bitter.

In this respect the upper Snake area is not materially different from other sections but there appears here to be a

growing tendency to try to adjust these disputes without violence and without recourse to long drawn out litigation. This attitude is believed to be largely attributable to a so-called "Committee of Nine" whose members are elected each year by the water users to act as advisors to the district water master. At any rate this committee has been most helpful in making contacts between the administrative officer and the individual water users. They pass upon the annual distribution expense budget, all matters of policy which are not clearly defined or established and in many other respects may be compared to a board of directors for the water district of which the water master or deputy commissioner of reclamation is the general manager.

The writer has had the privilege of filling the latter position and that of special deputy in charge of stored water delivery since May, 1919, and in addition has acted as district engineer for the U. S. Geological Survey in charge of hydrometric work within the same area. In March, 1923, and subsequently each year he has also been elected to the position of water master, thus further centralizing the water distribution administration. A skeleton organization consisting, in addition, of two engineer assistants and a clerk is now maintained throughout the entire year while deputy water masters, hydrographers and other employees are added as needed during the summer months. A limited edition, special report of each year's operations is prepared during the winter months while stream flow data are also made available through U. S. G. S. Water Supply Papers and the biennial reports of the state commissioner of reclamation.

While of necessity details have been largely omitted and many important phases of the work have been touched upon very briefly, it is sincerely hoped that this outline of procedure which has stood the test of many years actual operation may be of value in other sections where similar problems are either now being encountered or where they may develop with more complete water usage.

Sterling Perfects Unitype Drive

(Continued from Page 74)

and ready for immediate consumption by the user.

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TYPICAL TEST SHEET

NAME *San Joaquin Light & Power Corp.*
DISTRICT *Selma* DATE *7/13/27*

EQUIPMENT

METER *Westinghouse* NO. *102950*
AMPS. *5* VOLTS *500*
MOTOR *U. S.* H. P. *50* RPM *1200*
VOLTS *440* FRAME NO. *667-B*
SERIAL NO. *45352*
PUMP *Sterling—D. W. Turbine No. 3967*

TEST RESULTS

RPM—Motor and Pump	*1157.5*
Standing Level Below Base of Pump	*17.08'*
Pumping Level Below Base of Pump	*32.75'*
Draw Down	*15.67'*
Pressure Head Above Base of Pump—50 lbs.	*115.50'*
Total Pumping Head	*148.25'*
Gallons Per Minute Pumped	*1041.00'*
Miners Inches Pumped (9 GPM per MI)	*115.66'*
Acre-feet Pumped in 24 Hrs.	*4.6*
Kilowatt Input to Motor	*40.93*
Horsepower Input to Motor (Brake—48.3)	*54.86*
K.W.H. per M I in 24 Hrs.	*8.49*
K.W.H. per Acre Foot Pumped	*213.46*
Overal Efficiency	*70.94%*
Pump Efficiency	*80.61%*
Percent Full Load Input to Motor	*96.24%*
Line Voltage	*428-430-428*
Amps. per phase	*67-69.5-71.25*
Volts to Ground	*216-370-216*

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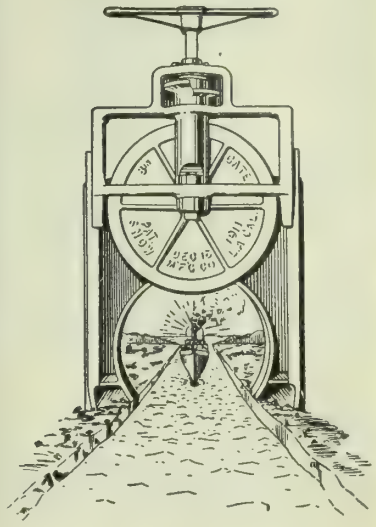
The development of the Sterling deep well pump has covered a period of over ten years, during which time the manufacturer has had the opportunity to perfect his product to a very high degree of efficiency. These pumps are made from the finest of materials, and the workmanship upon them is second to none. The company also maintains an engineering department and testing laboratories, for the purpose of maintaining the present high standard, and if possible to further perfect their products.

Plan County Water Survey

An expenditure of $7500 over the next three years has been contracted for by Ventura County, California, for a survey of the county water supply. The contract has been entered into with the state division of water rights, which will contribute the balance of the $15,000 to be used in the work. The survey will include the entire county and its purpose will be to ascertain the available water. The problem of obtaining the water and its quality will not be touched, it is said, by the survey, which is entirely a quantitative one.

SPECIFY



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WHO'S *WHO* AND WHO'S *WHERE*

IN THE WORLD OF HYDRAULICS

Personal Notes and Impersonal Observations About Men You Know

Assistant Commissioner P. W. Dent is acting commissioner of reclamation during the absence of Dr. Mead in Palestine.

H. E. Everett, sales manager of the American Seamless Tube Corporation, Los Angeles, has recently returned from a business trip to San Francisco, Bakersfield, Taft, Ventura and Santa Maria.

Wayne Tiner, for the past year resident engineer of Waco, Texas, in connection with the construction of a new sewage disposal plant, has been appointed city engineer of San Angelo, Texas.

Rhea Luper, state engineer of Oregon, went to San Francisco in August to confer with holders of Oregon irrigation district bonds relative to the reorganization of certain of the districts under an act passed by the last legislature.

Louis C. Hill, consulting engineer of Los Angeles, California, visited the Denver office of the Bureau of Reclamation recently in connection with his report on the proposed power development at Elephant Butte Dam, Rio Grande project.

J. E. Collins, superintendent of service of the American Seamless Tube Corporation, has returned to Los Angeles from a four months tour of South Africa where he has been servicing products of the company now being used on that continent.

J. F. Kunesch has gone to Honolulu as hydraulic engineer for the water resources branch of the U. S. Geological Survey in cooperation with the Honolulu Sewer and Water Commission, and will have charge of the investigations, designs and comparative estimates of various surface water supplies for the city of Honolulu. Mr. Kunesch has been with the U. S. Geological Survey in California and Arizona and later organized the hydrographic division of the irrigation service for the government of Haiti.

John F. Wilson, the new Skagit county manager for the Oregon-Washington Water Service Company, has taken charge of the company's recently acquired properties in Sedro-Woolley, Mount Vernon and Burlington, Washington. The main office will be located in Mount Vernon.

D. W. Stuver, reclamation engineer for the Puget Sound Bridge and Dredging Company, spent some time in August investigating the feasibility of the Murtaugh project, Idaho, which proposes the development of more than 40,000 acres in Twin Falls and Cassia counties.

James F. Miller, of Vale, Oregon, has joined the J. G. White Engineering Corporation and will do investigation work for the Mexican Irrigation Commission in Mexico. Mr. Miller has been with the Bureau of Reclamation in Idaho and Oregon and with private irrigation companies for a number of years.

W. M. Reed, chief irrigation engineer of the U. S. Indian bureau, in company with L. M. Holt, supervising engineer of the bureau, visited the locations of the proposed Wapato pumping plants, Yakima, Washington, the latter part of August, in order to investigate the physical features of the project.

C. E. Seity, agricultural engineer of the Virginia Polytechnic Institute, Blacksburg, Va., and B. G. Locher, a large land owner of that state, were recent visitors at the Oregon Agricultural College, Corvallis, Oregon, where they were investigating irrigation methods. They expected to go from the Oregon institution to the California State Farm at Davis, California, and from there to points in Southern California.

W. H. Nalder, assistant designing engineer of the bureau of reclamation, spent several days recently on the Kittitas High Line canal, Washington, now under construction by the bureau. The purpose of his visit was to keep in touch with actual conditions encountered on the work.

George C. Kreutzer, director of reclamation economics, Bureau of Reclamation, made a recent trip through eastern Oregon in company with W. G. Ide, manager of the land settlement department of the Portland and the Oregon State chambers of commerce. They visited the Vale and Owyhee projects to look over the situation and lay the foundation for an intensive campaign to settle the vast tracts of land which will be reclaimed.

Porter J. Preston, superintendent of the Yuma project in Arizona, R. P. Teele, economist in the department of agriculture, and C. A. Engle, supervising engineer of the Indian service, Blackfoot, Idaho, have been appointed by Secretary Work as a committee to investigate the need for further extensions of time for the repayment of charges on some of the reclamation projects. The committee recently visited the Minidoka project with the special object of securing data on irrigation pumping, cost of electric power, etc.

Blake R. Vanleer, professor of mechanical engineering in the University of California, has been awarded one of the Freeman traveling fellowships by the American Society of Mechanical Engineers. These awards are the gift of John R. Freeman, past president of the A.S.M.E., who created a fund for the study of flood prevention. This year, in order to make a definite contribution in the national emergency created by the Mississippi overflow, Mr. Freeman has made it possible for the A.S.M.E. to send two men to Europe to make an exhaustive study of hydraulics instead of one man as would customarily be the case.

Warren D. Smith, head of the geology department of the University of Oregon, has been appointed consulting geologist for the Bureau of Reclamation in the investigation of a dam site for the $21,000,000 Owyhee project. Dr. Smith succeeds Kirk Bryan, of the United States Geological Survey, who has been forced to discontinue his survey because of ill health.

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HYDRAULIC Engineering

With which is included

MODERN IRRIGATION and WESTERN WATERWORKS

Vol. III | OCTOBER, 1927 | No. 10

THE SOURCE OF THE LOS ANGELES WATER SUPPLY—OWENS RIVER.

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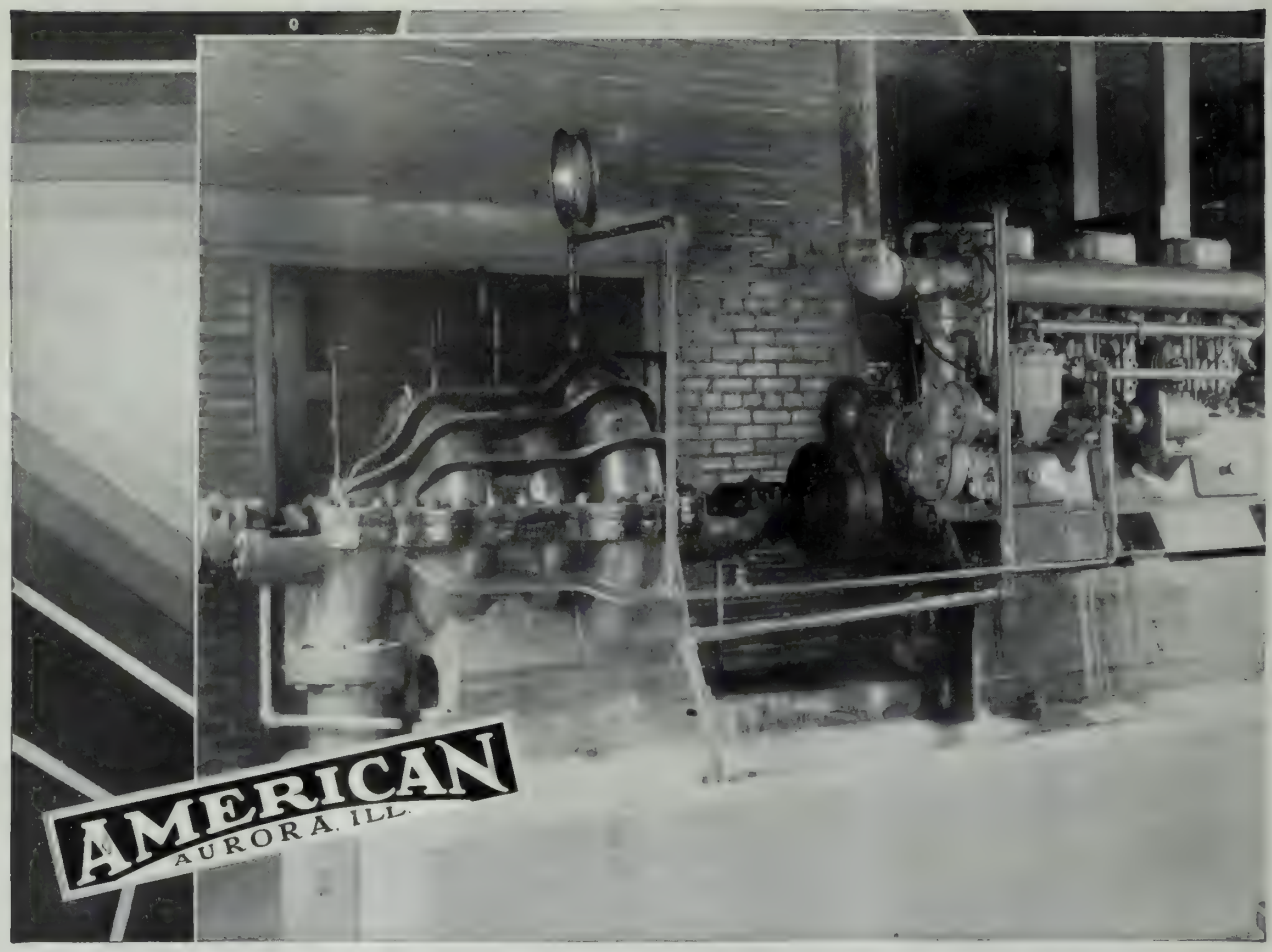

"American" Pumps at Opelika, Alabama

See Our Exhibit at the Sixth National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York, December 5 to 10, 1927

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TWO six-inch, three-stage, split-shell "American" centrifugal pumps, one of which is illustrated above, are installed in the Opelika, Alabama Water Works. These pumps are provided with automatic hydraulic balancing devices, which compensate for end thrust. Each of these two pumps is designed for a capacity of 1,000 G. P. M. against a 330-foot total head when running at a speed of 1,250 R. P. M. Being of the split-shell type, the interiors of these pumps are readily accessible for cleaning or repairs. The motive power of both pumps are six-cylinder gasoline engines.

There is also installed in this station a six-inch, two-stage "American" centrifugal pump designed for the same capacity as the other pumps when operating at a speed of 1,750 R. P. M. The drive for this pump is a 150 H. P. electric motor. The consulting engineers for this installation were Robert L. Totten, Inc., of Birmingham, Alabama.

THE AMERICAN WELL WORKS

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PETROLEUM WORLD 819 SANTEE ST., LOS ANGELES, CALIF. HYDRAULIC ENGINEERING

"Western Waterworks" Begins on Page 25

EDWARD HYATT, JR.

Newly appointed California State Engineer, succeeding Paul Bailey. Mr. Hyatt was formerly Chief of the State Division of Water Rights, and upon the resignation of Mr. Bailey was named as his successor by Director of Public Works Bert B. Meek. The duties of his new position are not at all unfamiliar to Mr. Hyatt, as his previous experience in the Division of Water Rights enables him to assume immediate command and carry on the extensive development program that has been planned.

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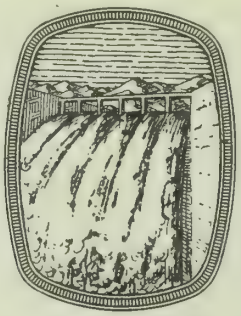

Volume III OCTOBER, 1927 Number 10

Modern Irrigation Becomes Hydraulic Engineering

THIS ISSUE of the publication appears under a new name, HYDRAULIC ENGINEERING. Those who have followed the development of the water resources of the West, over the last three-year period, realize that there has been but one publication dealing exclusively with the problems of the hydraulic engineer, and that publication has been MODERN IRRIGATION. Since the inception of the magazine, approximately three years ago, there has been a natural tendency on the part of its many readers to demand more and more editorial material of a purely engineering flavor; and, during the past ten or twelve months, MODERN IRRIGATION has carried in its columns, very largely, the executive and engineering type of article, dealing with various hydraulic problems of the West.

In tracing the history of water development, we need not go back more than fifty years to the time when old "millwrights" were the men who actually performed all the work that was done in this country in the development of water power. All the knowledge they needed was carried under their hats, so to speak, with perhaps some few rules and tables copied in a private notebook. Today, however, an engineer-executive who conducts a water development enterprise of any magnitude must, either directly or through competent assistants, be familiar with the latest practices of stream gauging, dam construction, hydraulic motors and regulators, electric generation, transmission and ultilization, power house construction, pumping plant design, to say nothing of such matters as the relation maintaining between engineers and contractors, executive methods, dealing with labor organizations, franchises, and riparian rights. It may be well, also, for him to know how to handle a board of directors and to float a bond issue.

It is true that in a majority of cases no one engineer is called upon to perform all of these duties; but the fact remains that, in the aggregate, engineers are doing all of these things; and that every successful engineer today finds himself constantly in need of knowledge that he cannot carry in his head and for which he must rely on the experience of others as recorded in professional literature.

This brings to the engineer the problem of digging out of the mass of things offered him the material which he wants and needs, and puts up to the makers of this literature the problem of how to turn out their product in usable form; how to give the engineer what he needs and give

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it to him in such a shape that he can make practical use of it.

In other words, it has become apparent that the solution of this problem lies in the direction of specialization. This is an age of specialization. In law the lines of specialism are drawn very fine and there is hardly a lawyer whose field of activity is not well fenced in; and in medicine, the all-around family doctor of a generation ago has given way to a hundred or more specialists. In the engineering profession, too, specialization has become the order of the day; but it is a thing more recent than we are likely to realize. The only real hydraulic engineering done a century ago was in the construction of canals. The profession naturally developed with the growth of the country along more or less distinct lines, but its formal differentiation into the four great branches of Civil, Mechanical, Electrical, and Mining Engineering has taken place within a quarter of a century. Today, each of these great divisions has its own special literature.

First water being turned out of the Bowman Reservoir, Nevada Irrigation District.

MODERN IRRIGATION was started, primarily, for the purpose of acquainting the executives and technicians of large western water development projects with the progress that was being made in this particular field. It was soon found, however, that the readers of this publication were made up, to a very large extent, of different types of hydraulic engineers, contractors, and project executives engaged actively in the industry, who desired supplemental material upon each of the projects described, and this material was of a more technical nature. This reader-demand became more and more insistent upon the publishing of technical material applicable to the entire hydraulic field; and so, in view of the fact that MODERN IRRIGATION (HYDRAULIC ENGINEERING) is today the outstanding publication in the whole field of hydraulic engineering, the publishers deemed it only proper to have the name of the journal conform more closely with its editorial contents.

This change of name, incidentally, does not mean in any sense a change of editorial policy. This policy will be, in the future, just as it has been in the past: one devoted to the interests of applied hydraulics, regardless of whether these interests appertain to any particular industry or to the allied hydraulic industries as a whole. Often times the editorial staff does not agree with the opinions of some of its contributors, but our attitude always has been that any subject of a sufficient interest to create diverse opinions among real authorities is worthy of publication, if only in order to bring forth additional opinions from other technicians of recognized standing.

The Advisory Board of *Modern Irrigation* will automatically become the advisory board of HYDRAULIC ENGINEERING. Western Waterworks, published as a supplement to *Modern Irrigation*, will occupy the same position in HYDRAULIC ENGINEERING. The necessity for a continued thorough coverage of this particular field is becoming more and more apparent, as evidenced by the very keen interest displayed in the magazine by engineers connected with municipal water supply systems of all types, and the strong subscription list which has been built up among men of this class.

The editorial scope of HYDRAULIC ENGINEERING is, perhaps, best indicated by the descriptive lines which appear in the lower panel of the front cover of this issue. These include: Irrigation and Reclamation, Waterworks and Sewage Disposal, Drainage, Land Development, and Water Power Engineering. Putting it another way, the magazine will continue to deal in a very concrete and practical manner with hydraulic dams and reservoirs, canals and pipe lines, and the multifarious problems growing out of the proper construction and maintenance of modern water supply systems of every description.

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Centrifugal Cast Concrete Pipe Line for City of Riverside Completed and in Operation

Tests Being Made By Fred C. Scobey, Hydraulic Engineer, to Determine Actual Coefficients Applicable to This Type of Pipe Line Construction

By EDWARD R. BOWEN

Consulting Engineer, Reaburn and Bowen, Los Angeles.

THE factors controlling the design of the Riverside, California, water conduit left only 15 feet of head available for friction and other losses in a distance of 42,000 feet under a maximum delivery of 20 second feet. The average hydraulic gradient is 0.35 feet in 1,000 feet.

With these small friction losses available, it was realized that a pipe line of good alignment and extremely smooth interior surface was necessary to meet the hydraulic conditions. Not only was it necessary to obtain these conditions at the time the pipe line was installed, but they must also be maintained throughout the life of the pipe inasmuch as a demand for its total capacity would probably not accrue for a period of 20 to 25 years.

The permanency of the construction was also a factor of importance, it being highly desirable to obtain a long lived structure.

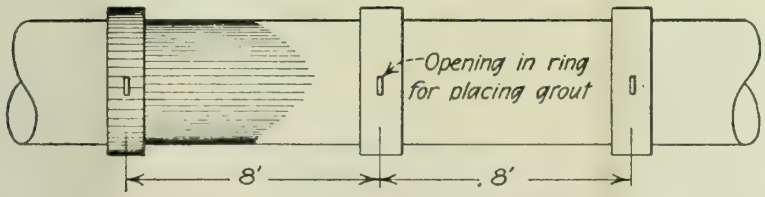
In the writer's judgment, a concrete pipe line best met these conditions and the development of the centrifugally cast concrete pipe in this district within the last year or two appeared opportune, as the quality of this product was, in my judgment, far superior to any other concrete pipe with which I am familiar.

The diameter of the line is based upon the Scobey coefficient of 0.345 in the Scobey formula $V=CH^{0.5}d^{0.625}$. The Scobey coefficient adopted corresponds to a C=120 in the Williams and Hazen formula, and to N in the Kutter formula of .012 for pipes up to 24 inches in diameter and .013 for pipes greater than 24 inches in diameter.

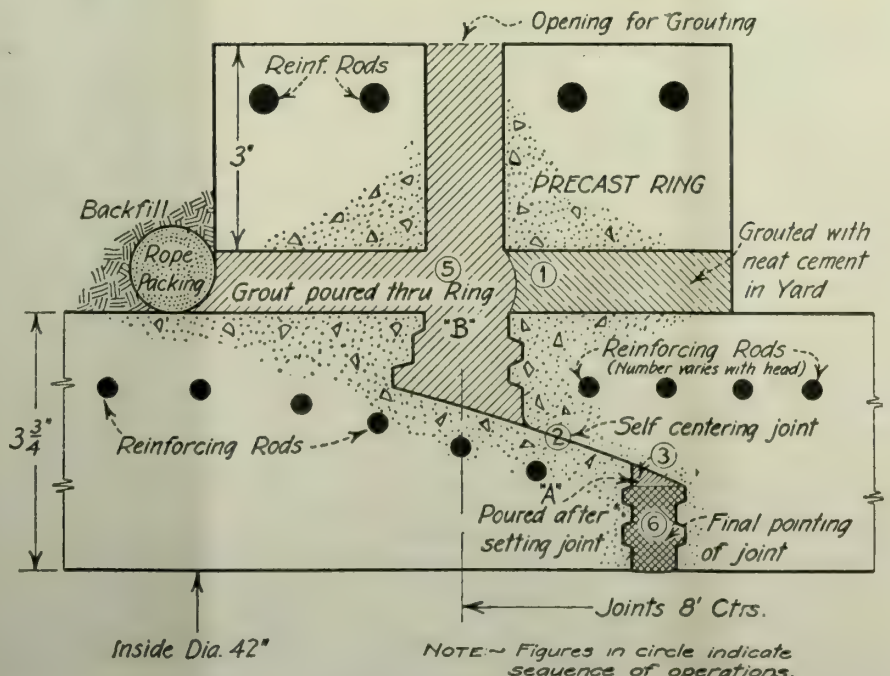
Scobey Test

The installation is completed, and was placed in service during the month of September, 1927. Inasmuch as there are no technical data available upon the flow of water in pipe lines of this character, the Board of Public Utilities of the City of Riverside communicated with Fred C. Scobey, Senior Irrigation Engineer of the United States Department of Agriculture, and requested that the pipe line be studied with the view of making available technical data bearing upon the capacity of pipe lines of this particular type. Mr. Scobey is an authority upon this subject and has published several bulletins of the United States Department of Agriculture dealing with the flow of water in pipes and canals of various character.

Following this request, Mr. Scobey spent practically six days of September in testing the flow of the Riverside pipe under varying conditions. The water was measured over a five-foot weir at the intake of the pipe line and the pressure losses were determined by mercury manometers at three places along the pipe. The manometers were attached through corporation cocks which were installed at the time the pipe line was constructed and made flush with the interior of the pipe. Any minor vibrations at the corporation cock were minimized by ordinary piezometer tubes in 3-inch pipe nipples attached to the corporation cocks. These piezometer tubes had four 1-16-inch holes which would reflect pressure head only, the object being to secure net pressure rather than velocity heads. The manometers were engine graduated to one-hun-



PLAN OF PIPE IN TRENCH



SECTION OF JOINT

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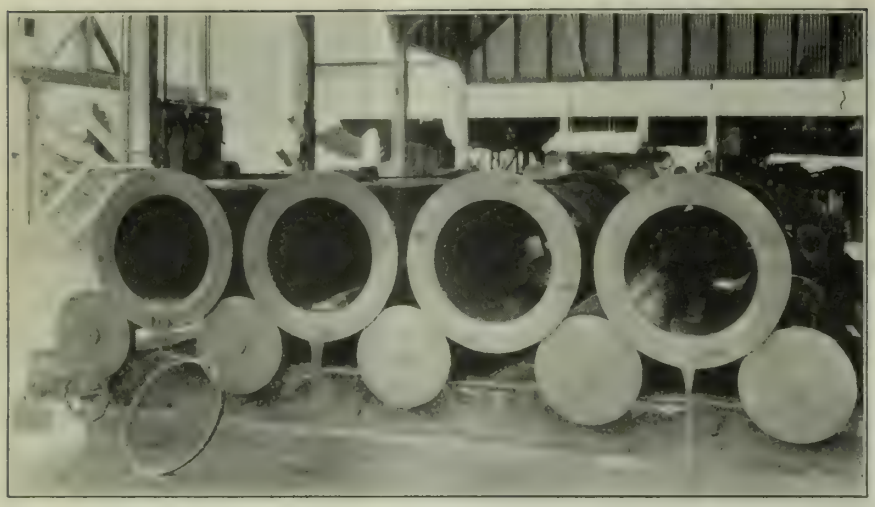


Draining the surplus water from the Hume pipe. This operation takes place between the initial spin and the packing or final spin.

dredths of a foot and readings were taken to one-thousandths. The basic plane was established by static conditions of the pipe line and afforded a perfect datum to work upon.

Although a final analysis of the data assembled by Mr. Scobey will not be available for some time, preliminary figures indicate that the pipe line as constructed will operate with a coefficient between .370 and .385 in the Scobey formula which is equivalent to a value of C in the Williams-Hazen formula of nearly 140. These figures are based on over all loss, including over 700 degrees of curvature, many manholes, valves, etc.

The maximum flows available at this time are not sufficient to test the pipe line under maximum carrying conditions, and the highest velocity now obtainable is only about two feet per second. The tested velocities are so low and the friction losses are so small that any experimental errors are a much greater proportion of the total loss of head than they would be if greater velocities were possible. We appreciate that the results obtained are tentative and subject to verification by other tests on this particular type of concrete pipe.

Hume Centrifugal Pipe

The Hume centrifugal pipe comes to us from the patentees, the Hume Brothers of Adelaide, Australia. The process has been used with success during the last six or eight years in Australia, South Africa and England. There are seven thousand miles of pressure line work installed in Australia, some of which is as large as 72 inches in diameter.

This pipe is now being fabricated in Southern California by two manufacturers, the Bent Concrete Pipe Company and the Western Concrete Pipe Company.

The major installations in California are the construction of about 17,000 feet of 18 and 27-inch diameter pipe for the Laguna Beach Water District, and the installation at Riverside comprising about 40,000 feet of 42-inch diameter pipe operating under heads up to 105 feet. Both these lines were built by the Western Concrete Pipe Company.

Riverside Pipe Line

The Riverside line is in general an inverted syphon with seven summits. It is divided into four sections by 36-inch main line gates. These gates include 6-foot steel tapered sections on either side. Four-inch Simplex air and vacuum valves were installed on each side of the main line gates and at all summits. The pipe is equipped with blowoffs or drain valves at all sags or low places in the line. Manways are left in the pipe at approximately 1,000 foot intervals and pressure outlets were attached where necessary. The manways and outlets are fastened on saddle clamped to the pipe and bedded in concrete.

The specifications for the fabrication of the Riverside pipe were drawn in a rather broad manner, it being the intention to specify the results desired rather than the method of obtaining them. The proportion of the aggregate and the cement were specified for a minimum cement content, it being left to the discretion of the manufacturer to vary the proportions for the best results. The proportions actually used averaged one part of cement to two parts of sand to 1.1 parts of stone. They varied somewhat with the aggregates and the pressures to which the pipe was to be subjected.

The reinforcement consisted of No. 8 gauge black annealed wire proportioned to withstand the entire internal pressure on the pipe at a unit stress of 16,000 pounds, neglecting the tensile strength of the concrete.

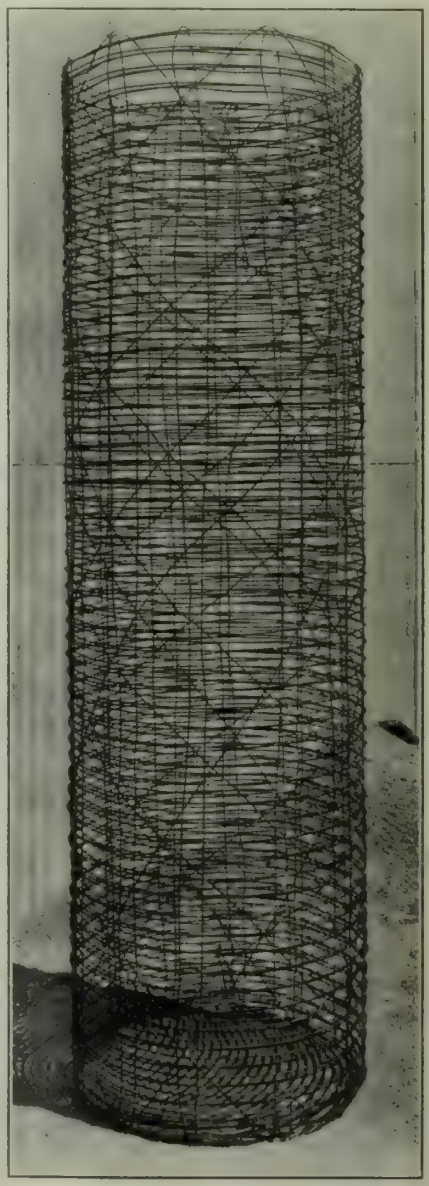
The tolerance in the dimensions of the pipe were 3-8-inch variation from a true circle or 1-4-inch under the 42-inch diameter.

The specifications provided for curing under low temperature steam for at least 12 hours before the forms were removed, and storage under sprinklers for six days, the first three days being under burlap. No pipe was removed from the yard until it was 14 days old.

Acceptance Tests

Yard tests for both internal pressure and external load were specified.

One length of pipe out of every 25, selected at random, was tested under hydrostatic pressure to 120 per cent of the working pressure to which the pipe



Finished Hume pipe re-inforcing cages. Note that these cages are symmetrical and rigid.

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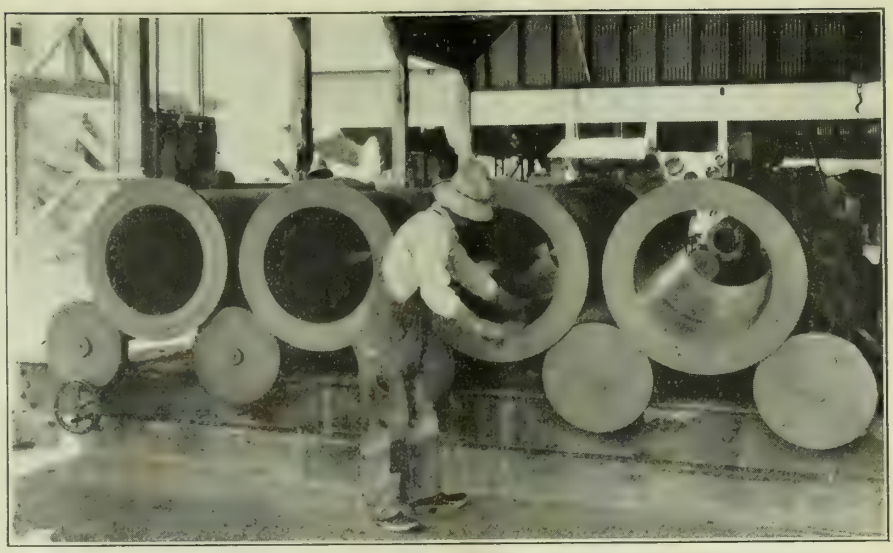
would be subjected but all pipe must withstand a pressure of not less than 25 pounds. To successfully pass the test the pipe must show no cracks and have no noticeable seepage. One length of pipe out of every 100 lengths was tested for external pressure by supporting the lower one-fourth of the circumference in a uniform bed and loading uniformly the upper one-fourth of the circumference. The pipe should successfully withstand an external load of 4,000 pounds per lineal foot and failure was deemed to have occurred when the pipe showed a clearly visible crack. No pipe failed to pass the yard tests.

A field test provided that the pipe line was to be subjected to 150 per cent of the maximum working pressure for a period of 4 consecutive hours. The leakage under this test should not exceed 200 gallons per inch of diameter per mile of pipe per 24 hours.

This test was made on about 35,000 feet of line and resulted in a leakage of but 17 per cent of that allowable. The result of this test, together with the fact that there was not a single bad joint developed in the entire installation leads to the conclusion that the methods adopted for the joint construction and installation are well advised and successful.

Fabrication and Construction

The process of fabrication consists of placing the mixed concrete materials in steel forms mounted upon driving drums and rotated with a variable peripheral speed. The forms are rotated during the time the concrete is being placed at a speed sufficient to insure a uniform distribution of the aggregates throughout the wall of the pipe under the centrifugal force. After the form contains sufficient concrete to give the required shell thickness, the peripheral speed is increased to about 2,100 feet per minute and continued for a period of 8 to 15 minutes according to weather and other working conditions. Spinning is then stopped and the excess water, latents, bits of wood or other foreign materials are brushed from the inside surface. The pipe is then respun for a few minutes and a smooth interior surface is produced by burnishing with a steel rod and leather trowels.



The interior of the pipe is burnished with an iron bar and leather trowel. The above picture shows this operation.

Field Joints

The sections of the Riverside pipe are 42 inches inside diameter, 8 feet long and have a shell thickness of 3 3-4 inches. They are reinforced for pressure equivalent to heads of 50 feet, 75 feet, 93 feet and 105 feet. The sections are joined together as shown in the sketch. The male and female ends of the pipe make a self-centering joint. The collar is caulked to the female end in the yard with a dry mix of neat cement, in the same manner as a cement joint in a cast iron pipe is formed. Particular pains were taken to see that this caulking was driven up hard. When the pipe is placed in the ditch, the alignment is carefully checked and just enough cement mortar is placed on the inside of the pipe to seal the point "A." Rope packing is then placed around the pipe at the exterior of the open end of the collar as indicated and the back-fill brought up over the pipe. A liquid grout is then poured into the annular space marked "B." This mortar is poured through a long nozzled funnel down one side of the pipe until it flows out from the opposite side. The ditch is next water settled. The inside of the joint is subsequently pointed with cement mortar, care being taken to equalize over a distance of 6 or 8 inches any inequalities in the centering of the pipe. The result of this practice is to provide an interior barrel which is true to line and extremely free from waviness.

In my judgment, the success of the field joints is due to the fact that the pointing on the inside of the pipe was done after the line had been backfilled and the ditch water settled. The pipe was not then subjected to stresses resulting from wide temperature variations between night and day. As soon as practicable after the section of the line had been completed, an inspection was made on the inside of the pipe. Any hair cracks were readily discernible and were cut out and repointed before water was turned in.

A section of the 42-inch Hume pipe being tested by hydrostatic pressure. This section was subjected to an internal pressure of 85 pounds, and showed no seepage.

*A paper presented at the 8th annual convention of the American Waterworks Association, San Jose, October, 1927.

E. L. Sparks, formerly New York district manager for the Williams Bucket Company, has joined the Thew Shovel Company, of Lorain, Ohio, and has been put in charge of sales in California. James S. Griffin has been appointed representative for the company in New Mexico, Colorado, and Wyoming, with headquarters in Denver.

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Experimental Work on Small-Scale Models of Arch Dams Begun by Reclamation Bureau

Miniature Models of Arch Dams, Built to Exact Scale, Loaded With Mercury, Provide Data Required in Design of Full-Size Structures

By IVAN E. HOUK

Research Engineer, Denver Office, Bureau Reclamation

ONE of the most important secondary investigations being conducted by the Bureau of Reclamation at the present time is the experimental work on small-scale models of arch dams. It is expected that the investigations will furnish definite information as to the safety of arch dams already built or now being constructed by the Bureau of Reclamation, demonstrate the feasibility or infeasibility of using small-scale models in planning costly arch-dam structures, and provide the complicated technical data neded for comprehensive engineering studies of arch dams. It is anticipated that the experimental data obtained will make possible a more exact, and consequently a more economic, design of arch-dam structures, thus tending to permit the development of proposed irrigation, water power, and other engineering projects not heretofore considered financially feasible.

One of the most important investigations still under way, is that of the Stevenson Creek Arch Dam. The above photograph was taken last winter when water overflowed the structure.

The model experiments are being carried on at Boulder, Colo., in cooperation with the University of Colorado and the Engineering Foundation Arch Dam Committee. In fact they may be said to constitute one part of the comprehensive research work being carried on by that committee. A subcommittee on model tests, appointed by chairman Charles D. Marx of the main committee, is cooperating with the representatives of the Bureau of Reclamation in outlining, supervising, and conducting the investigations. This subcommittee is composed of Chief Designing Engineer J. L. Savage, of the Bureau of Reclamation, chairman; Consulting Engineer D. C. Henny, of Portland, Ore.; Consulting Engineer F. A. Noetzli, of Los Angeles, Calif.; Engineer-Physicist W. A. Slater, of the Bureau of Standards; Prof. Raymond E. Davis, of the University of California; Prof. George E. Beggs, of Princeton University; Profs. F. R. Dungan, C. L. Eckel, and H. J. Gilkey, of the University of Colorado; Engineer Julian Hinds, of the J. G. White Co. of Mexico, formerly of the Bureau of Reclamation; and the writer.

The experiments will be made in the basement of the testing laboratory at Boulder, where the testing equipment, instruments, and other experimental apparatus of the university will be available for the use of the testing staff. An experimental concrete pit, with massive, heavily reinforced sidewalls and floor, has been built below the floor of the basement to serve as a site for the model dams. The pit has a depth of 5 feet, a maximum inside length of 18 feet, and a maximum inside width of 12 feet. One of the accompanying illustrations shows the plan of the pit, a longitudinal cross section along the center line, and a transverse cross section through the center. The octagonal, stepped design will permit the testing of models of practically any shape, symmetrical or nonsymetrical, and of practically any size not exceeding the maximum inside dimensions of the pit.

Careful study has been given to the possibility of using different materials in building the models. Hard rubber, celluloid, plasticine, gypsum, cast-iron blocks, and other materials have been considered as possible substitutes for concrete, the material now invariably used in the construction of full-size dams. Very careful study has also been given to different methods of loading the models, such as loading by springs, by mercury, by water, by water pressure transmitted through inclosed horizontal lengths of rubber hose laid along the upstream face of the model, etc. The conclusions reached were that the first models shoull be built of concrete, that they should be tested under triangular loads obtained by holding a film of mercury against the upstream face of the model, and that experiments with other materials and other methods of loading should be deferred until the results of the first tests are available.

The first experiment to be conducted will be an investigation of a 1-12-scale model of the Stevenson Creek Test Dam, the 60-foot symmetrical arch dam which was built by the Engineering Foundation Arch Dam Committee for the purpose of studying the action of arch dams. The model will be 5 feet high, 11 feet 8 in-

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ches long, 2 inches thick at the top, 7 1-2 inches thick at the bottom, and curved on a radius of 8 feet 4 inches. It will have the same V-shape as the Stevenson Creek Test Dam and will be built in one end of the pit where the arch elements can abut against the side walls at an angle of approximately 90 degrees. A plan, elevation, and vertical cross section of the model at the location of maximum height are shown in one of the accompanying drawings. Arrangements are being made for a shipment of fine aggregate from the Stevenson Creek site to Boulder, for use in building the model, so that the concrete in the model will be very nearly identical with that used in the actual dam.

Loads and Measurements

Loads on the model will be obtained by forcing mercury into a rubber bag held against the upstream face of the model. The rubber bag will be held in place by a 1-4-inch sheet steel form, curved to the same radius as the upstream face. Heavy timber bracing will hold the form in position, and air pressure will be used to force the mercury from the supply tank into the rubber bag. Since mercury is 13.6 times as dense as water, a dam 5 feet high, loaded with mercury, will be subjected to the same pressure at the bottom as a 68-foot dam loaded with water.

Very careful measurements will be made of the movements of the model when the load is applied. Deflections of the down stream face will be observed at approximately 40 points, by means of dials reading directly to one ten-thousandth of an inch. Invar steel rods, whose lengths do not change with variations in temperature, will transmit the movements of the down-stream face to the measuring dials, the rods being arranged as shown in the accompanying plans. The movement of the model at the upstream edge of the base will be measured at the crown section where the formation of a crack is anticipated. Movements of the abutments will be observed at three elevations corresponding to the elevations at which similar measurements were made at the Stevenson Creek Test Dam. Strains at the down-stream face of the model will be measured with the optical strain gage developed by Doctor Tuckerman, of the United States Bureau of Standards. Repeated observations with this instrument, made by different persons, have demonstrated its ability to measure strains in a 2-inch gage length with an accuracy of one four-millionth of an inch. Investigations are being made to determine the feasibility of using this instrument in measuring other deformations of the model, such as changes in length of mid-ordinates in a 10-inch chord length, angular rotation of different elements of the model, deflections near the base of the model, etc.

The decision to build a model of the Stevenson Creek Test Dam for the first experiments was based on the fact that complete data regarding deflections, strains, bending, movement of abutments, temperature effects, etc., are available for that structure, the first series of experiments by the Arch Dam Committee having been completed and the data now being practically ready for publication. It is expected that a comparison of the experimental data obtained on the model with that obtained on the actual dam will determine the relations between a small-scale concrete model loaded with mercury and a full size structure loaded with water. These relations can then be used in interpreting the results of subsequent model tests. They will also be of value in deciding whether it is advisable to conduct experiments on models built of other materials.

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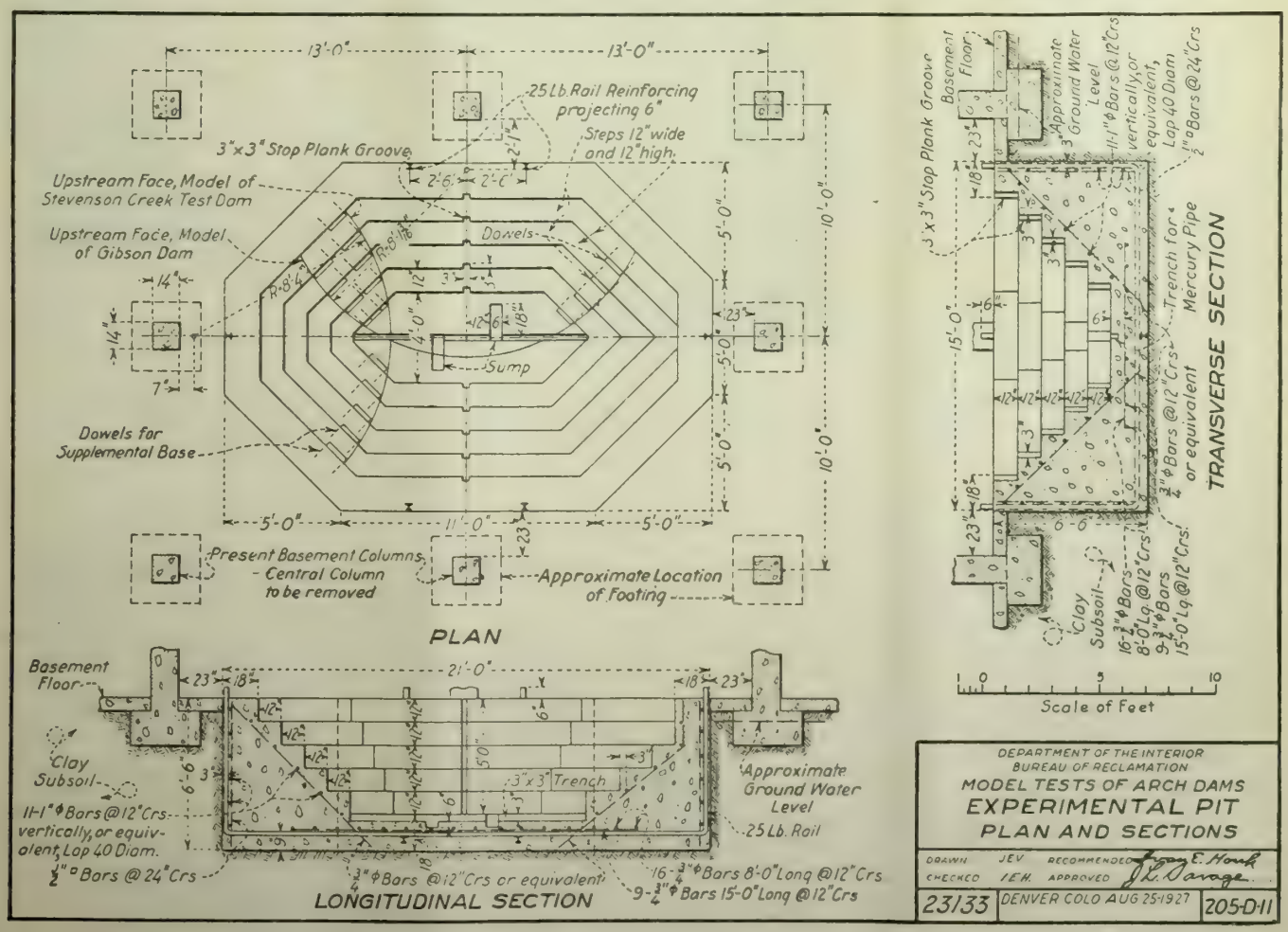

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Should Method of Water Right Evaluation Follow Any Precedent or Set Rules

Author's Discussion Enumerates Factors That Should Have Decided Effect Upon Any Appraisal Methods Utilized

By JOSEPH JACOBS*

IT is not infrequently contended, in the valuation of public utility properties, that no allowance should be made for water rights because the actual ownership of the water vests in the public, and there have been many findings and rulings by public service commissions sustaining this view. As against allowing nothing for the water right a more equitable showing could be made for the principle of dividing the water right value between the public and the utility owner, in those cases where the water right value is based upon consideration of the extra cost involved in developing the next best available water supply. This would be upon the theory that the consumer public would otherwise lose, completely, the money value of its natural advantage of location with respect to the cheaper supply.

That water rights do have value, however, and that this shall be recognized as a principle in public utility valuations, unless there be definite stipulation to the contrary, has been too often attested in decisions of our higher courts to be any longer seriously questioned. In the recent Indianapolis Water Case the U. S. Supreme Court said "the water rights must be included."

Further evidence that owners attach value to their water rights inheres in the history of the violent and costly struggles and encounters, both physical and judicial, that have been engaged in to establish and maintain such rights.

PUBLIC LANDS

The Federal Power Commission also, in a way, recognizes this principle of water right value as evidenced in its published rules and regulations which provide, in respect of power developments on government land within its jurisdiction, that the licensee shall pay an annual fee, based upon the installed capacity of the plant up to the power capacity of the site, ranging from 5 cents per horsepower for the first year of operation to 25c per horsepower for the third and subsequent years of operation. These figures have definite capitalized values depending on the assumed earning capacity of money and, with a known power head for any given case, these values could be expressed in terms of dollars per second foot of water. While it is believed that thus basing the charge upon plant capacity may indicate recognition by the commission of the principle of water right value, the charge is not, of course, a measure of such value. In the first place the commission says the charge is "for reimbursing the United States for the cost of the administration of the act." In the second place the charge may be considered as being in part for rental of land occupied by the project and, if the available water supply is in excess of any possible power market demand, it may be regarded as attaching more to the power franchise than to the water right, for such a distinction can be made.

JOSEPH JACOBS

Member of the consulting firm of Jacobs and Ober, of Seattle, Washington. Mr. Jacobs has specialized in hydraulic engineering since 1905, and among his many commissions has been engaged as consultant to the U. S. Reclamation Service for a considerable portion of his professional life.

It is easier to prove that water rights have a value that should be recognized, than it is to determine what that value is. The valuation method to be used, and the final value arrived at, depend in part upon the purpose of the valuation, in part upon whether a private industry or a public utility is being dealt with, and finally upon the elements that make up the value of the water right. It is not possible to formulate a simple definition of what these elements are because of the many qualifications and exceptions that have application to specific cases. Moreover, by reason of statutory differences, what may be valid in one State, respecting water rights, and their valuation, may not hold in another State. Time is not available to enter into any detailed discussion of the numerous factors that have a bearing upon water right valuation and the most that can be attempted here is a brief reference to some of the more important considerations that may be involved. Among these are the following:

(a) The State laws and regulations upon which the validity of the water right rests.

(b) The priority, amount and duration of the water right as defined by court decree or as effected by franchise. This involves also the question of storage rights as distinguished from normal flowage rights.

(c) The franchise, and the limitations thereof, under which is operated the project to which the water right attaches. A short lived franchise would detract from the value of a water right and the franchise may even stipulate that no value shall attach to the water-right under certain conditions.

(d) The amount that was legitimately expended, by purchase or otherwise, in securing the water rights.

(e) The value, for agriculture or other ordinary purposes, of the land occupied in the development of the water-right, as for instance the land required for dam, for power house, for canal headworks, etc.

(f) Whether or not the project to which the water right attaches is fully or only partially developed and whether the market for the product that the project supplies is immediate or only prospective and whether it is permanent.

(g) The abundance of the water supply. A supply in excess of present and prospective market requirements would tend to depreciate, as would a restricted supply tend to appreciate, the unit value of a water-right.

(h) The cost of the next best available

(*Continued on Page 55*)

*Extracts from a discussion given by the author upon a paper presented by John E. Fields at the July 14, 1927 meeting of Amer. Soc. Civil Engrs. at Denver, Colorado.

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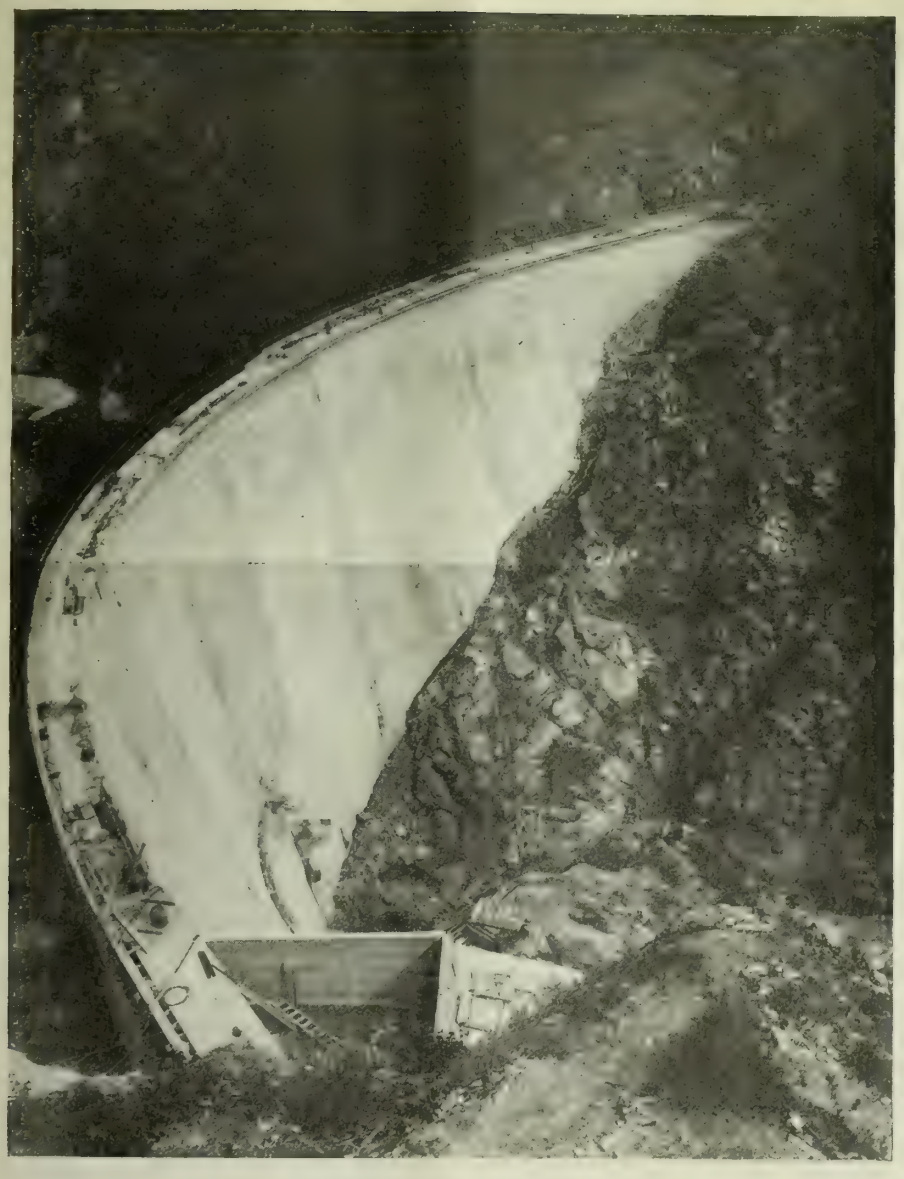

The Big Santa Anita Dam is the latest structure to be completed by the Los Angeles County Flood Control District.

Two Flood Control Dams Completed

Los Angeles Flood Control District Completes Two New Structures Which Provide Protection for Valley Farms

By S. M. FISHER

Chief Designing Engineer for District

THE Los Angeles County Flood Control District has recently completed two of its dams, the Sawpit and the Big Santa Anita, which were included in the $35,000,000 bond issue of May, 1924. Both dams are of the arch type, the Sawpit being of constant radius and the Big Santa Anita of the varying radius of "constant angle" type.

The location of the Sawpit Dam is in the canyon of the same name at a point approximately two miles above the city of Monrovia. This location offered a very desirable site, the granite bottom and side walls allowing the construction of a structure 162 feet in height, above the foundation, with a crest of 539 feet in length. The reservoir created by this dam has a storage capacity of 1,600 acre feet. The upstream face of the dam is vertical, and the entire structure is arched to a radius of 265 feet. The thickness at the top is 8 feet, and at the base is 63 feet.

Construction operations commenced in April, 1926, and the dam was completed in May, 1927. The excavation amounted to 45,220 cubic yards, and there was poured 56,350 cubic yards of concrete. The total cost of the structure was $611,000.

Big Santa Anita Dam

The second structure to be completed by the Flood Control Districts was the Big Santa Anita Dam, which is located in the canyon of the same name, approximately 3 miles north of the city of Arcadia. The Big Santa Anita stream, together with its tributaries, has a drainage area of approximately 13 square miles, and discharges into the San Gabriel River between the cities of Arcadia and Monrovia. This stream, in the past has done a great amount of damage to agricultural and residential property in the vicinity of these cities, and in order to prevent this the dam was constructed.

The location selected for the structure is a very favorable one, the blue granite bed rock and side walls being bare. The dam is 225 feet in height, above foundation, and is 600 feet in length at the crest. The thickness at the top is 7 feet and at the base 61 feet. The reservoir created by this structure has a capacity of 1,500 acre feet.

Work on the Big Santa Anita dam started in March, 1925, and was completed in March, 1927, requiring two years for the construction. The excavation amounted to 75,000 cubic yards, and there was poured 76,000 cubic yard of concrete. The total cost of the structure was $1,211,000.

The Dalles Has Irrigation Plan

The possibility of having 1000 acres of orchard land under irrigation next year is announced in a recent report from The Dalles, Oregon. An organization has been formed for the co-operative drilling of wells. Drilling operations will be directed by a board appointed by the organization. It is hoped to complete ten wells between now and the irrigation season next spring. Estimating that each well will average a supply for 40 acres of land, this will means 400 acres under intensive development. Another 400 acres will be added by the opening of the new Sorosis park line of the city water supply. The Cherry Hill well will furnish water for 100 acres, and other wells to be drilled outside the co-operative plan will make up another hundred.

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The EDITORIAL

HYDRAULIC Engineering
With which is included
MODERN IRRIGATION—WESTERN WATERWORKS

Reg. U. S. Pat. Off.

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RUSSELL R. PALMER
Editorial Director

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Vol. III OCTOBER, 1927 No. 10

"Hydraulic Engineering"

THIS month's cover bears a new name for the journal which you have been reading the past three years—a name more broadly expressive of the editorial contents. The advisability of a change in name has been apparent for the past year; more especially, since it has been carrying a steadily increasing volume of material upon various hydraulic developments of the west which are mainly of a technical nature.

To engineers who were not thoroughly acquainted with the editorial contents and policies of *Modern Irrigation,* the name suggested farming and agriculture, and the same suggestion was carried to the advertiser. *Modern Irrigation* did not carry editorial material designed for the agriculturist, although many agriculturists, who might also be designated as water developers or "irrigationists," in the broader usage of that term, do read the magazine religiously.

However, the greater portion of the circulation has been obtained among the various types of hydraulic engineers and executives, as well as among contracting firms engaged upon projects in this field.

During the past year, too, there has come a very desirable type of circulation, wholly unsolicited on the part of the publishers but obtained through a purely natural demand or reader-interest. This circulation is primarily foreign, scattered throughout the world. Mexico is well represented, as are South America and Africa, Siam, Germany, Australia, Borneo, and our nearby neighbors, Canada and the Hawaiian Islands. Circulation of the nature just referred to is very gratifying to the publishers, because it proves quite clearly that the magazine is sufficiently in demand to warrant foreign readers puzzling over the natural idiomatic expressions characteristic of our American engineers, in order to obtain the basic material they desire.

The editorial articles have been, for the most part, of an engineering nature, dealing with the whole broad field of applied hydraulics. The various departments which are covered monthly include waterworks, irrigation, reclamation, flood control, sewerage, water purification, water transmission and delivery, dam design and construction, hydro-electric development, and in fact any and all problems of direct interest to the hydraulic engineer.

In the future this magazine will continue to carry articles similar to those it has published in the past and for which it has gained such an enviable reputation. The change in name in no way indicates a change in policy, but merely denotes the true character of the magazine as is now expressed by its title.

A. S. M. E. Hydraulic Section

THE importance of hydraulics is reflected in a recent announcement sent out by the Pacific Coast Section of the American Society of Mechanical Engineers. This latter was to the effect that a Hydraulic Division of the Society had been formed and was about ready to function.

It is the duty of this founder society to organize various divisions in certain sections of the country where a specialized industry is being developed. It was but a relatively short time ago that this same society organized a Petroleum Division, in order that the members that were directly connected with the oil industry could gather together and discuss their mutual problems in detail. This new division will, in all probability, function in a similar manner to the Petroleum Division.

The chairman of the new Hydraulic division is E. C. Hutchinson of San Francisco, and H. L. Doolittle of Los Angeles has been named as secretary. At the present time the division is segregating those members of the society whose interests are primarily in the field of hydraulics, and no doubt, it will be but a short time before there will be regular meetings, and the presentation of papers upon subjects affecting the hydraulic industry.

Irrigation

WHEN thinking of irrigation one is apt to assume the idea that the United States has a corner on such development, and that the rest of the world is very much in the dark ages of hydraulic develop-

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POINT *Of* VIEW

ment. According to a survey recently made by the United States Bureau of Reclamation, irrigation is practised in virtually every section of the world, and the United States ranks but second in the total area under such treatment. It is suprising to learn that India has more than two and one-half times the acreage under irrigation that the United States has, and that the small island of Japan, irrigates nearly one-half the acreage that this country does.

In actual figures, there are 20,000,000 acres subject to irrigation in the United States, and such countries as Argentina, Egypt, Italy, Java, Mexico and Russia, each have nearly half this amount. Other countries have lesser amounts, more in proportion to their size, and the total amount of acreage under irrigation in the entire world runs approximately 137,500,000 acres. From these figures it can be seen that there is still room for a great amount of additional development in this country.

Which Way Blows the Wind

DURING the past five years the California Department of Public Works has been carrying on a survey and examination of the waters of the state. This work, which already has cost over four hundred thousand dollars, and which is now nearing completion, has proved to be one of the most valuable and constructive investigations of the kind ever undertaken. In its broadest aspect, this survey has worked out what amounts, virtually, to an inventory of the water resources of California, with complete data and findings covering practically every stream and watershed in the state. It is the first time in the history of California that such information has been so completely and comprehensively assembled.

Contrary to widely held opinion, the climate of California is not changing; nor has any appreciable climatic change taken place there during the records which extend over a period of some seventy years. From year to year the conditions may wabble above or below normal, but government records show that the average warm and cold weather will, over a reasonable cycle, sum up to normal.

According to the United States Weather Bureau, a marked decrease of the snow pack in the mountains is registered over the last twenty years. The importance of this snow pack cannot be over estimated, because it is this reserve that provides the run-off for the summer months. During the years 1907 to 1916, the average snowpack at three stations was eleven feet, while for the same period, and at the same stations during the years 1917 to 1926, the average pack was but seven feet.

California has suffered from droughts, and has had seasons when the precipitation was far above normal, and these conditions will continue; but, on the whole, there has always been and always will be a superabundance of natural run-off. The major problem of California is the conserving of this natural run-off, and the providing for its storage and distribution during the summer months when it is decidedly needed.

The general plan ventured by Paul Bailey, while in the position of State Engineer, has been a subject of much discussion and one upon which experts have diverse opinions. By some it has been considered as the only salvation of the state; by others, as a wild Utopian dream. Engineers, who are generally known for their conservatism, say very little upon the subject, and take the attitude that the proposition will require considerable more study and thought than has been given up to this time.

At present, the new political organization which holds the reins of California's engineering personnel, is still in a formative stage; and engineers who are vitally interested in the state's hydrauic development are waiting anxiously for some sign or straw that will indicate the attitude of the new Director of Public Works, and his able assistant, the new State Engineer.

American Falls Dam

NO objective can be of greater importance to Idaho either now or in the future, than the conservation of water and the putting of it to beneficial use, in order that unproductive lands may be developed into productive areas. There is no more praiseworthy work than that of building dams and reservoirs, in order that there may be impounded the flood waters now wasting. Conservation of these waters means the underwriting of the agricultural crops that any state raises upon its various irrigation projects.

The dedication of the American Falls Dam, built by the United States Reclamation Service at American Falls, is of the most importance to the State of Idaho, as it marks the conclusion of another chapter in the history of irrigation development of the country. American Falls Dam was dedicated September 28th, 1927.

The American Falls reservoir was constructed at a cost exceeding $3,000,000. It is nearly a mile in length, averages 83 feet in height, and is 75 feet wide at its base. It required an average of 400 men working ten hours daily for a period of two years to effect its completion. The reservoir that is formed behind the dam inundates 61,000 acres of land, nearly 88 square miles.

Irrigation projects are a practical application of progress. They may mean the bringing under cultivation of additional lands to which there is an objection by those who feel there is now an over-production, but they cannot be stopped, nor is it apparent that they ever will be stopped. If the claim that there is an over-production due to too much land had any merrit, the settlement and development of land would have ceased years ago. That would have meant stagnation of the country. Under such conditions the West could never had developed, and Idaho, Utah, Washington, and California would still be a wilderness.

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Scientific Development of Irrigated Farms May Cause Decrease in Rural Population

Advancement of Irrigation Practices and Invention of Labor-Saving Devices Increase Output of Farm Labor

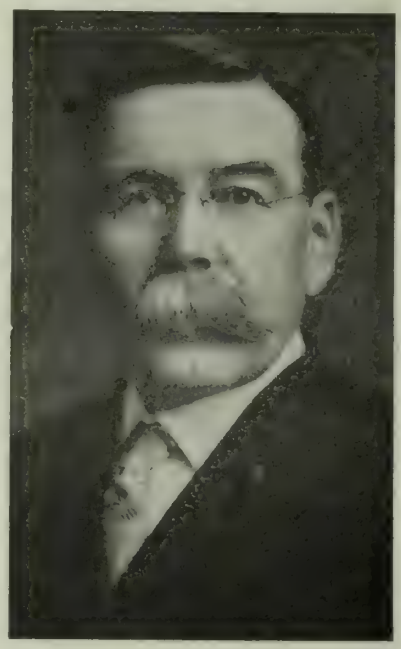
By SAMUEL FORTIER*

THIS beloved West of ours is a land of little rain. Nature has provided bountifully for most of the wants of man but as regards water she has seen fit to put us on a third ration. For aught we know there may be infinite wisdom back of this restriction. Climate has always exercised a great influence on our ancestors. In the early stone age which is placed between 50,000 to 125,000 years ago, our rugged ancestors may have had a fairly prosperous if strenuous time, for the climate in northern latitudes was then warm. In the middle stone age the climate was much colder and man moved south or was forced to live in caves.

The later stone age which occurred from 8,000 to 10,000 years ago, was characterized by a milder climate which still continues, and a more rapid development along many lines. For example, the Egyptians invented the first calendar 6,168 years ago, and since that time we moderns have had a better knowledge of the existence of ancient peoples. In tracing their rise and progress and subsequent decay over a period of several thousand years, it is interesting to note that the highest civilizations were found in arid and semi-arid countries—the elevated tablelands of Manchuria which are supposed to have been the cradle of some existing races; the extensive valley watered by the Tigris and Euphrates rivers in Mesopotamia, the valley of the Nile in Egypt; Northern Africa as well as Italy, Spain and Southern France.

Water Shortage Promotes Study

These countries, like Western America, are all arid or semi-arid, and yet it was there that the highest civilizations of ancient times flourished. Was this a mere coincidence or was it because the framing and execution of customs, regulations and laws relating to water and the skill necessary in handling it sharpened mens' wits and created a spirit of cooperation and mutual regard which was lacking in the nomads who flitted from place to place, pasturing their herds? I am inclined to think it was the latter. It was the scarcity of water and its high value as a national asset in producing food that bound nations to the irrigation canal. It is 2,500 years since Nebuchadnezzar reigned, but the records engraven on clay tablets which have been discovered and translated, seem to deal largely with the use of water for irrigation purposes. In like manner it is safe to conclude that the wise use of the Nile for agricultural purposes gave the Pharaohs much more concern and induced deeper study than the building of the pyramids. There is good reason to believe too, that the water supply for the numerous baths of Rome, some of which were conveyed over forty miles, and the irrigation of the gardens of the beautiful suburban villas cost much more planning and study than was ever devoted to any military campaign.



SAMUEL FORTIER

Senior Irrigation Engineer, Division of Agricultural Engineering, Bureau of Public Roads, U. S. Department of Agriculture.

These brief allusions to ancient peoples and ancient times should give us courage to carry on even if our water ration is only one-third that of the world in general. Our duty is clear. We must conserve Nature's small water supply and put it to the best possible use. We must hand over to our descendants better systems of distribution and use, and better customs and laws than we inherited from our parents.

California Irrigation Studied

Fifteen years ago we were all at sea as to the ultimate developments of irrigated agriculture in California. The State was then irrigating some 3,000,000 acres, less than half today's total, but no one knew and no one was wise enough to predict how much more land could be reclaimed. The extent of arable land was variously estimated at from 20 to 30 million acres, but it was not known how much of this could be irrigated with the limited water supply. I believe I may be credited with starting the investigation which found the figure. We placed in a budget all the Federal funds we could muster and then went to Sacramento and begged from Dr. Pardee, who was then Governor, an additional sum to put it across. Dr. Pardee generously provided about $20,000.

The undertaking was placed under the leadership of Frank Adams, and in 1913 a report on the irrigation resources of California and their utilization was published by the Government together with a carefully prepared map of California in three section—Southern, Central and Northern California. Although this report was preliminary in character and incomplete in many ways yet I have always regarded it as worth many million dollars to the citizens of this State.

Comprehensive Plan of Development

The results of investigation showed that the surface waters alone if conserved would irrigate a large area, but having no funds to survey reservoir sites we were unable to determine how much water could be stored. Our estimate of irrigable land for the entire State was accordingly placed at the conservative figure of 10,000,000 acres. We knew this much land could be reclaimed but we were uncertain of the additional amount. Since that day the State through its Department of Public Works has expended several hundred thousand dollars in determining the maximum

(*Continued on Page 48*)

*Presented at the joint meeting of the Western Irrigation Equipment Association, the California Concrete Pipe Manufacturers' Association, and the Northwest Concrete Pipe Manufacturers' Association, held in San Francisco, California, July 15, 1927.

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Scientific Explanation of Corrosion Theory and Simple Methods of Prevention

Economical Utilization of Effective Pipe Coverings Greatly Lengthens the Service Life of Underground Conduit

By F. L. MARK

Engineer Pipe Line Division, Pioneer Paper Co., Inc.

DETERIORATION of metal structures by corrosion has come to be recognized as one of the most vital problems of present-day industry. It has been estimated that yearly replacement to offset the damage caused by this factor will amount to as much as two per cent of the total tonnage in use. Industries using metal pipe are particularly affected by this wastage, in view of the millions of dollars invested in lines for carrying water, gas, and oil, and the wide range of conditions which must be met by these lines.

Of the many explanations which have been advanced for the process of corrosion the electro-chemical theory is today most generally accepted, and is so well known as to require little introduction. It suffices to say that this theory, and other theories which have been advanced, presuppose that moisture and in most cases oxygen must come into intimate contact with the metal before corrosion can take place Therefore, a protective coating that will exclude moisture and oxygen will prevent corrosion as long as the coating itself resists deterioration.

Demonstration of the application of Pioneer pipe wrapping with a Wieland pipe wrapping machine to pipe previously coated with Rubbertex, a new Pioneer product which prevents deterioration of metal structures by corrosion.

The material used for such a coating should be economical and easily applied, and in the case of pipe covering should have inherent resistance to weathering, oxidation, moisture, and the action of most chemical substances. It should possess high di-electric strength, to shield against electrolysis from stray currents. Susceptibility to temperature changes should be low, so that the material will not become brittle at low temperatures, or so fluid at high temperatures as to melt and run off the pipe.

Bituminous substances possess this combination of qualities to a high degree, and their use as a base for pipe protective coverings has been demonstrated for many years. Contemporary reports of the Paris Universal Exposition of 1867 mention the great interest aroused by the exhibit of a process in which pipes for gas and water mains were built up by dipping paper in melted bitumen and then rolling around a cylindrical mould, to form a laminated tube. At the same exposition pipes coated with a bituminous mixture according to the Chameroy system were exhibited, and it is stated that great quantities of such pipe were laid for gas and water mains in the City of Paris, between 1856 and 1866.

It has been demonstrated that the protection afforded by simply dipping the pipe in hot asphalt, or by painting the pipe with asphaltic compounds, is to be regarded as temporary only and does not give satisfactory results over a long period of time. The asphaltic coating in such cases is likely to be abraded or chipped off in handling, and maintains its protective characteristics only under especially favorable conditions. For long resistance to corrosion under the varied conditions of actual use, it is generally conceded that the asphalt coating must be kept in place and reinforced by an outer covering. Best results have been obtained by methods in which the initial coating of asphalt is covered by a spirally wrapped fabric of asphalt saturated and coated felt. This outer covering may be applied by hand, but more uniform results are obtained by wrapping machines of the portable or stationary type. Machine wrapping is more economical due to the greater speed of application.

A typical pipe wrapping machine is shown in the accompanying illustration. The clean pipe is ordinarily first treated with a suitable priming coat, either by mopping or by the hot dip process, best results being obtained by the latter method. The wrapping machine applies the final coating of asphaltic material, simultaneously wrapping the pipe with one or more spiral layers of felt, saturated and coated with asphalt. The felt may be applied flat to the surface of the pipe, or the successive spirals may be lapped so as to seal the edges of the covering. Excellent results are obtained by applying two layers simultaneously, with the spirals flat to the

(*Continued on Page 50*)

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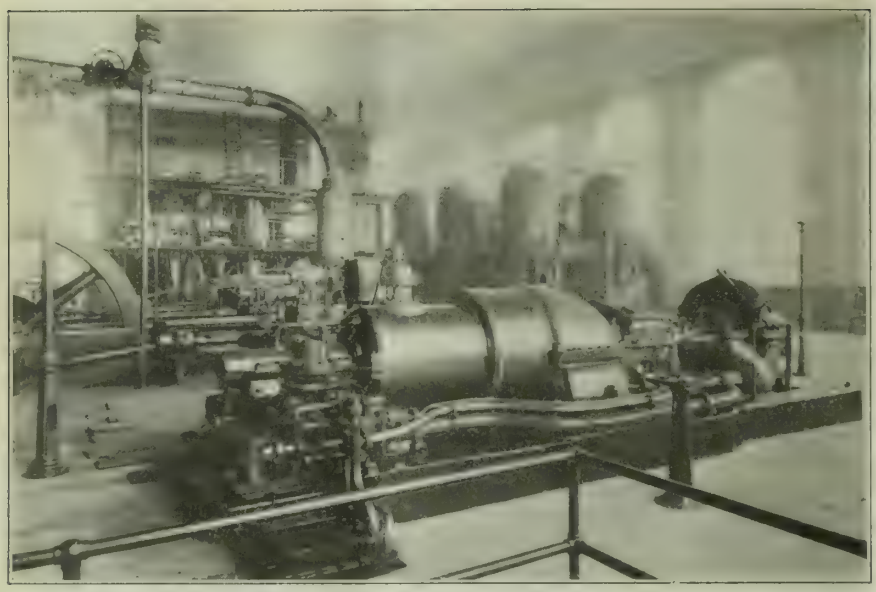


Steam Turbine Reduction Gear Driven Centrifugal Pumping Units installed in an eastern city. These pumps are rated at 15 M.G.D., 183 foot head, 1040 R.P.M. (Turbine Speed 3900 R.P.M.). In the background is a 12 M.G.D. Vertical Triple, and a 15 M.G.D. Horizontal Triple Pumping Engine.

Greater Efficiency of Pumping Units Shown in Recent Installations

Use of High Speed in Centrifugal Pump Design Allows Manufacturer to Build Units of Greater Efficiency

THERE have been no radical changes during the past year in the way of centrifugal pumping equipment for water works service, but considerable progress has been made in improving and refining the details of the design of all centrifugal pumps. This has resulted in making the equipment more efficient, durable and easier to maintain.

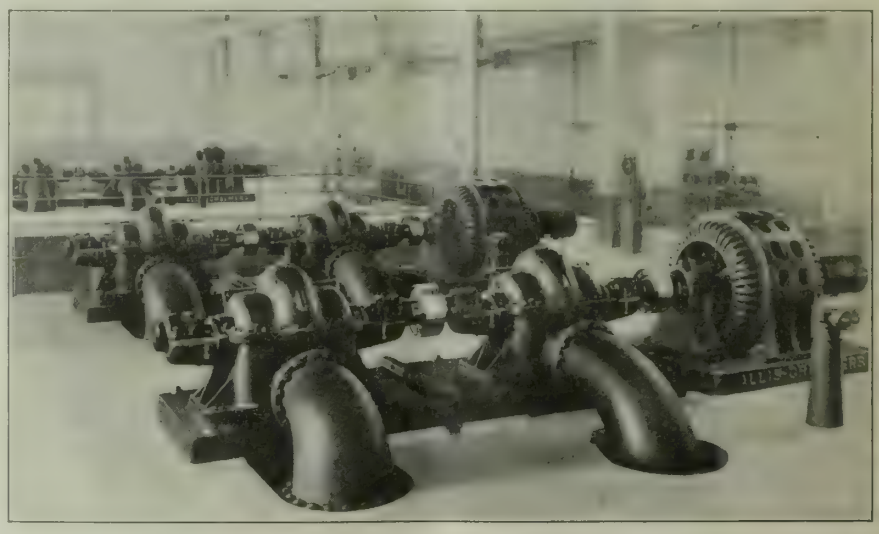
The increased efficiencies which are being obtained from centrifugal pumps are bringing about two notable changes in water works practice; one of these is the increasing application of geared steam turbine driven centrifugal pumping units in place of reciprocating pumping engines. The centrifugal units cost considerably less than the latter type, and with the higher steam turbine and centrifugal pump efficiencies, the economy is not enough less than that of pumping engines to justify, in very many cases, the higher cost of the reciprocating type of machnery. The accompanying photograph, shows a geared steam turbine driven centrifugal pumping unit in the foreground, then a horizontal crank and fly-wheel pumping engine, and in the background a vertical, triple expansion pumping engine. This gives a good idea of the relative size of these different type units, the centrifugal unit being of 15 MGD capacity, the vertical triple expansion of 12 MGD capacity, and the horizontal pumping engine of 15 MGD capacity.

Use of Motor Driven Units

Another change is the increasing use of motor driven centrifugal pumping units for water works service. The improvement in efficiency of the centrifugal pump is a contributing factor in this change as well as lower power rates. The accompanying picture shows three high service Allis-Chalmers motor driven centrifugal pumping units installed at the Fridley Pumping Station, Minneapolis, Minnesota, and there are in addition three low service pumps not shown, which makes this pumping station one of the latest using motor driven centrifugal pumps entirely. The high service units shown on the photographs are rated 20 MGD against 225 feet total head and are driven by 1,000 HP, 900 RPM synchronous motors. These units on official test gave a combined efficiency of over 84 per cent, which is probably a new record in efficiency for units of the size and type mentioned. Two motor driven centrifugal pumping installations, however, one of moderate size and one of large size, where the efficiency obtained is over 84 per cent shows why the motor driven centrifugal pumping unit is coming in for more consideration as a waterworks pumping unit.

In regard to smaller size pumps, these types of units have also been improved and their efficiency increased. One factor which is responsible for this increased efficiency is the use of 3,500 RPM motors for driving the pumps, as this permits a comparatively high head to be developed with a small diameter, efficient impeller. The installation shown on the accompanying photo is a small 3,500 RPM pump acting as a booster for a deep well unit. With this hook-up the deep well pump delivers the water to the booster at the surface of the ground, and the high speed, high efficiency booster pump delivers it into the mains, making a quite economical installation.

(*Continued on Page 37*)



A view of three 1000 Horsepower Synchronous Motor Driven Pumping Units, rated at 20 M.G.D., 225 foot head, 900 R.P.M.

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WESTERN Waterworks
Supplement to Hydraulic Engineering
Of Interest Expressly to Waterworks Executives, Contractors, and Municipal Engineers

Joseph R. Ryland Heads California Waterworks Association For Coming Twelve Months

Record Attendance at Annual Meeting of California Section Evidences the Fact That Greater Interest is Being Taken In Waterworks Industry

AFTER shattering all records for attendance the Eighth Annual Convention of the California Section of the American Waterworks Association passed into history. There were 557 persons registered as attending the meeting, the largest number ever recorded by the section, exceeding by nearly two hundred the attendance at the San Diego meeting last year.

The first day of the meeting was given over to the inspection of the exhibits, arranged on the lower floor of the Scottish Rite Temple. The manufacturers who made these exhibits outdid all of their previous efforts, and the waterworks men apparently were attracted, judging from the crowded condition of the hall at all times of the meeting.

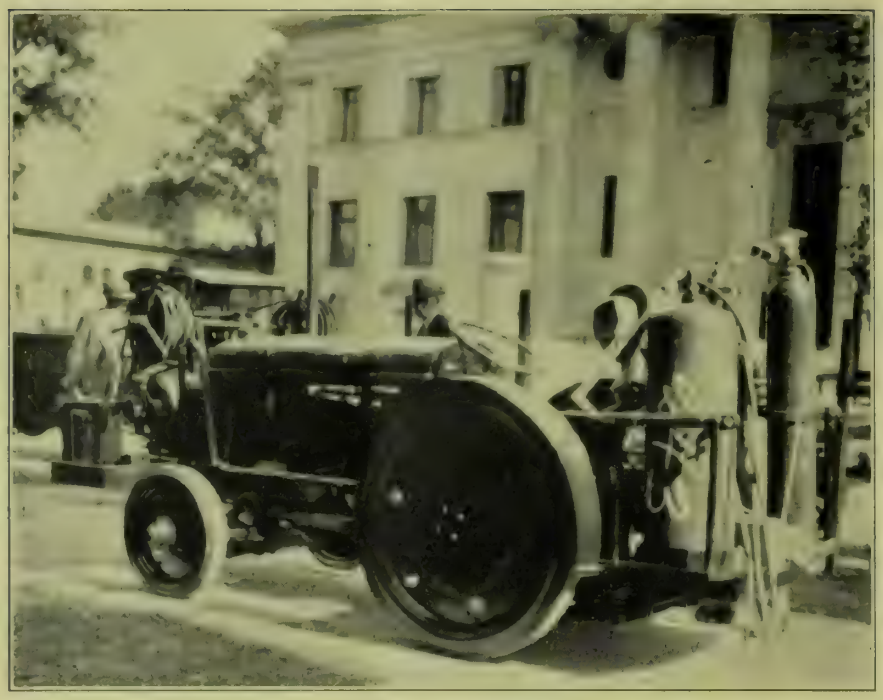
At the dinner meeting held at the hotel Sainte Claire, Joseph R. Ryland, president of the San Jose Water Works, was elected as president of the California Section for the coming year, succeeding Samuel B. Morris of Pasadent. The other officers named at this same meeting are as follows: Vice President, John Burt, manager of the Marin Water District; Secretary-Treasurer, W. E. Hurlburt, office engineer of the Los Angeles Bureau of Water and Supply. W. Olmstead of the Monterey Water Works, and W. Goebel, of the San Gabriel Valley Water Company, were elected to the executive board.

Joseph R. Ryland, president-elect, who during the past year held the position of vice president of the section, is considered one of the foremost public utility experts in the state.

The dinner meeting at the Hotel Sainte Claire, with approximately 300 delegates in attendance, was one of the outstanding events of the meeting. Besides the election of officers, there were a discussion upon the revision of the waterworks manual, reports of retiring officers, and reports of all outstanding committees.

L. L. Farrell, (center) and his crew of huskies, who put on the practical demonstration of modern waterworks practice at the San Jose Waterworks Convention.

One of the features of the convention was a practical demonstration of modern waterworks practises. This demonstration was held in St. James Park, opposite the convention hall, and was under the direction of L. L. Farrell,



A Fordson tractor, with rubber tired wheels, was so equipped that it provides energy for the arc welding apparatus, and carries necessary apparatus for oxy-acetylene welding and cutting.

superintendent of distribution for the East Bay Water Company of Oakland. This practical field show attracted virtually all of the waterworks men in attendance at the convention. Mr. Farrell showed methods of making connections to water mains, while these mains were in operation and under a heavy water pressure. The East Bay Water Company loaned, for the purpose of this demonstration, several truck loads of apparatus and equipment, in addition to a crew of assistants of eight or ten men.

L. L. Farrell, superintendent of distribution, East Bay Water Company.

Among the interesting equipment used in this demonstration was a Fordson tractor, on which was mounted a complete electric welding outfit, and an oxy-acetylene welding and cutting outfit. A photograph of this machine is shown on page twenty-six. This tractor was equipped with rubber tired wheels, so that it could be run under its own power from place to place along the paved streets of the city without doing damage to the street surface. The direct current generator was mounted upon a frame work in front of the radiator, and belt driven from the auxiliary power wheel of the tractor. The oxygen and acetylene bottles were set on another frame work at the rear of the tractor, adjoining the driver's seat. Auxiliary tools were kept in boxes conveniently located at different points on the frame work.

Insulating Joints

Among the other demonstrations made by Mr. Farrell was the use of a cement joint for insulating pipe line sections, and methods of controlling electrolysis in steel and cast iron lines. A set up, showing standard meter and service lines from mains to curb, gave the delegates from the smaller cities an idea to carry back with them. The electric welding machine, among many other interesting demonstrations, showed the possibilities of making a large size take-off, such as six, eight, or ten inch, by electrically welding a nipple of the proper size to the main while the latter was being operated at normal pressure. A cutting tool was then operated through the gate, and the opening into the main drilled out. The pressure value within the main did not affect any of these operations.

Technical Papers

The program as listed in the September issue of this publication was followed very closely. The opening address was given by City Manager C. B. Goodwin. A paper by Joseph R. Ryland followed immediately after. Owing to the illness of Mr. Ryland, one of his assistants read his paper. The next paper was presented by Edgar Allen Rowe, associate engineer of the J. B. Lippincott Company, Los Angeles, the subject being "Gunite Covered Steel Pipe and Centrifugal Concrete Pipe for the Laguna Beach Water District." Rowe's paper was followed by a general discussion, after which R. Stange, engineer for the national board of fire underwriters, read a ten minute paper on "Simple Methods of Taking Flow Tests from Fire Plugs."

During the discussion that followed the presentation of this paper Edward

"Alex" Bell, of Wallace & Tiernan fame, and "Doc" Wilson of the Los Angeles Bureau of Water & Supply sun themselves on the temple steps.

A. Reinke, of the state board of health, spoke on "Present Practise in Cross Connections." His topic was followed by a general discussion entered into by Joseph de Costa, East Bay Water Company; Morris S. Jones, Pasadena Water Company; Dr. Carl Wilson, Los Angeles Bureau of Water & Supply; and E. K. Barnum, president of the California Water Service Company.

Arthur Taylor, an associate engineer of the firm of Salisbury, Bradshaw, & Taylor was scheduled to read a paper on "Treatment of Sulphur Water" but owing to his absence, this paper was read by Ray Derby, also associated with

R. A. Stevenson (Sacramento) and C. B. Abbott, (Waterworks Supply Co.) discuses the convention.

the same firm. After the general discussion upon Mr. Taylor's paper, the first day's meeting was adjourned.

The meetings of the second day were also given over to the reading of papers and general discussions. The first discussion was led by John Burt, general manager of Marin County Water Department. The topic of this discussion was "Protection of Watersheds." Following Mr. Burt's there were discussions by George J. Davis, superintendent of the Peninsula water system of the Spring Valley Water Company; George W. Hawley, assistant chief engineer for the East Bay Water Company; R. G. Wueste, supervisor of impounding systems for the San Diego Water Company; Dr. Carl Wilson, director of the biological laboratories for the Bureau of Water & Supply, City of Los Angeles; and Ray F. Goudey, resident sanitary engineer for the State of California.

The second afternoon session opened with a paper presented by I. E. Flaa, assistant engineer for the Spring Valley Water Company. His topic was "Various Waterworks Jobs for 1927," giving a general resume of the activities for the year, with especial reference to the treating of steel tank construction. Following this paper, Edward R. Bowen, of the firm of Reaburn & Bowen, consulting engineers of Los Angeles, gave a descriptive talk upon the construction of the centrifugal cast concrete pipe line recently completed by the City of Riverside. This talk was illustrated with motion pictures. Fred C. Scobey, senior irrigation engineer for the Department of Agriculture, gave a short talk in connection with this paper. The meeting was then adjourned to St. James Park, opposite the convention hall, where the practical demonstration was made by the East Bay Water Company.

C. E. Rhein, district sales manager for Linde Air Products Company.

R. H. Corey, manager of the water system of Marshfield, Oregon, and F. M. Randlett, Pacific Coast manager of the Robert W. Hunt Company.

The last day of the convention was given over to an inspection trip of the watershed and pumping plants of the San Jose Water Company. During the lunch hour, a barbecue was held at Howell reservoir in the Los Gatos Hills. This barbecue was held on the hillside overlooking the lake, and began shortly before noon. There were over forty-five automobile loads of delegates, possibly numbering some 250 persons, that made this trip of inspection and enjoyed the picnic under the trees.

Geo. H. Bailey, Pacific Coast manager of the Neptune Meter Company (right) and Mr. Bixbey watch the field demonstration.

San Francisco was selected as the next convention city. This meeting will be consolidated with the annual convention of the parent body, the American Waterworks Association, this national session to be held early in the month of June, 1928. The Fairmont Hotel has been selected as convention headquarters.

Stockton to Tap East Bay Line

Stockton, California, hopes to secure a municipal supply of water, according to a recent statement by City Manager Charles E. Ashburner, by tapping the main pipe line of the East Bay Municipal Utility District. Negotiations with the East Bay district are about concluded, it is stated, by which the city will be able to divert its own water from the Mokelumne river through the Lancha Plana dam and the East Bay pipe line, at a cost of approximately two and a half or three million dollars.

L. E. Northrup of the Neptune Meter Company, and Wm. W. Hurlburt, office engineer of the Los Angeles Bureau Water and Supply. Mr. Hurlburt was elected secretary-treasurer of the section for the coming year.

Water Supplied to San Jose Through Dual System Which Utilizes Gravity and Pumping

Paper Presented at Annal Convention of California Section of A.W.W.A. Describes in Detail Water Impounding System of Convention City

By JOSEPH R. RYLAND

THE water supplied by the San Jose Water Works is from a dual system, that is to say, a gravity system with water from the Mountains southwest of San Jose, and a pumping system located in San Jose and vicinity.

The plant of the San Jose Water Works is divided into five divisions, viz., San Jose, Los Gatos, Saratoga, High Line and East Side Divisions.

The gravity system of the San Jose Division begins at the Williams Reservoir, which is located on the Los Gatos Creek a few miles almost due north from the mountain known as Loma Prieta. The natural flow of the creek, supplemented at times by the stored waters of the reservoir, is allowed to flow down the creek for the distance of about eight miles, to the Jones Dam, at which point the waters of the Los Gatos Creek, including those of the various side streams, are taken into the flume.

The Jones Dam consists of a concrete dam with filter galleries just above the dam in order that the water may be relieved of matter carried in suspension by it (such as leaves) and more or less purified of bacteriological germs. These filter galleries have been built in the creek bed and are so arranged that the sand filter which lies above them can be cleaned by opening a gate and allowing the water to flow freely, thus washing out the impurities which have been collected.

From the Jones Dam the water is carried in what is known as the flume, which is partly wooden flume, partly concrete flume and partly iron pipe, to the Los Gatos Reservoir, in the southern portion of the town of Los Gatos. Here all the water carried by the flume is chlorinated before it enters the reservoir, as are in fact other surface waters entering the system for use of Los Gatos and Saratoga. May I say in passing that during all the years we have been chlorinating the waters of the Los Gatos Creek we have never found a sample that a bacteriological test showed as dangerous. We have had a few doubtful, which, as you know, might have been due to conditions other than the water itself.

After leaving the Los Gatos Reservoir, the water is conveyed in a sheet iron pipe to the Seven Mile Reservoir, located on the State Highway a few miles north of the town of Los Gatos. From the Seven Mile Reservoir, the water continues in a sheet iron pipe to the Cambrian Reservoir, which is the pressure reservoir for the City of San Jose and vicinity. At the Cambrian Reservoir a portion of the flow is diverted to pass through the Wilbur J. Wilcox Fountain. From the Cambrian Reservoir there are two 18-inch sheet iron transmission mains to the distributing system, one of these mains entering the business section of the City from the west, via the Alameda, and the other from the south via Willow and First Streets.

At the corner of the State Highway and Bascom Avenue, where the Los Coches Pump Station is located, one of the transmission mains mentioned before is divided into two portions, each 20 inches in diameter, one of these continuing easterly along the State Highway, and the other northwesterly and then northeasterly to that portion of the City lying along The Alameda near the town of Santa Clara, where it crosses The Alameda and continues in an easterly direction to near the Guadalupe Creek. It is our intention to continue this 20-inch line to the northeasterly part of the City and then in a southerly direction to the Ribera Pump Station at 17th and Santa Clara Streets.

Laying steel mains which have been properly covered with protective material for prevention of corrosion. Courtesy Western Pipe and Steel Company.

The other line from the Cambrian Reservoir, which enters the City at its southern extremity, will be divided at the corner of the Meridian Road and Hamilton Avenue into two portions; one, the present 18-inch line, and the other, a 20-inch line which will be continued from the corner of Meridian Road and Hamilton Avenue through the Willows District and Cottage Grove to the southeasterly corner of the City, and thence northerly to the Ribera Station, passing the Las Candelejas Pump Station, the Aldea Pump Station and the Santa Marta Pump Station. When the 20-inch line is com-

pleted, the City will have an additional belt line completely surrounding it.

It may seem odd that we should have in two places an 18-inch line feeding two 20-inch lines. It is our intention to replace the present old 18-inch lines with 30-inch and 36-inch when the time comes that they should be renewed. As long as they continue to give good service, except as to size, we do not care to dig them up.

Going back to the mountains, there is, almost west of the Jones Dam, the Howell Reservoir. This reservoir is used for emergencies or to augment the flow of the Los Gatos Creek during times of summer low flow by allowing the water to pass to the Los Gatos Creek and enter it just above the Jones Dam, whence it can come with other waters to San Jose, as outlined heretofore.

Still further towards the northwest there is the Lake Ranch Reservoir. Originally constructed as part of the San Jose Division, the Lake Ranch Reservoir is now principally used as part of the Los Gatos Division though at times it is used conjointly by both the San Jose and the Los Gatos Divisions.

Two Belt Lines

At the present time there are two belt lines surrounding the business portion of the City, one 10 inches in diameter surrounding the densely built-up business section, which was installed mostly for fire protection, and a 12-inch belt line in the intermediate mixed business and residential district lying between the closely built business section and that which is entirely residential, while a gridiron pipe system has been installed connecting these belt lines with the main transmission line through the center of the City and with each other for general service to the consumer.

The pumping system of the San Jose Water Works consists of five pumping plants in operation, a sixth with a developed water supply but no pumping equipment yet installed, and a seventh where wells are being bored.

The method of operation is the same at all the stations whether the pumping is required to boost pressure in order to give service or to supply water when the flow from the Los Gatos Creek is insufficient to meet the demand of the San Jose Division.

All the stations are equipped with deep wells, and each well, with the exception of two where air lifts are used, is equipped with a deep well turbine pump for lifting the water from the underground supply to a tank on the surface of the ground, from which the pressure pumps take water. The tank at each station acts as a sand trap in case there is sand carried from the well, as sometimes happens with any well. The tank also allows the escape of any earth gas, thus keeping such gas out of the mains, and provides a constant head for the pressure pumps in case the delivery into the distributing systems should either be more or less than the supply from any well or wells that may be in operation.

In locating the various pumping plants we have endeavored to keep in mind the future growth of the City and have therefore so located all the plants that they are in touch with one another through the present distributing system and so that they will be directly connected with one another through the 20-inch belt line referred to as part of the gravity system briefly described before, when the 20-inch line is completed. Also we have endeavored to so locate pumping plants that should the pressure become deficient in any particular part of the City, it can be built up by some pump station conveniently located for that purpose.

Pumps Electrically Operated

All the pumps are operated by electricity normally supplied by the Pacific Gas and Electric Company, and such has been the excellent service received from that Company that during all times we have been using electricity for power there has never yet been a failure of power of sufficient duration or covering sufficient territory to embarrass us in any way in our pumping operations. However, there is always the possibility of the electric power being entirely cut off should we have a serious conflagration or earthquake, for we all know that in case of a severe earthquake the first thing to be done for the protection of lives and property is to shut off the electric current. Realizing this danger and believing that it might be essential for us to have at least one pumping plant capable of being operated independently of the Pacific Gas and Electric Company, in addition to the gravity supply, the Water Works has installed at its main station on Santa Clara Street a standby electric generating station of sufficient power to operate at normal capacity the main pump station.

The standby electric generating plant consists of two 300 H. P. gasoline engines, directly connected to the generators, and the plant is installed in a building which has been made as near earthquake proof as is practicable. This electric generating plant is turned over at regular intervals and is given a test run every week to insure its being in condition to operate in case of necessity, but, as said before, there has as yet been no occasion for its use during the many years we have been using electricity as power. On the other hand, the fact that this electric generating plant is in condition to run at a moment's notice has a very large beneficial influence upon the insurance rates for the City of San Jose and vicinity.

The East Side Division consists of a transmission line from the Ribera del Coyote Pump Station to the Penitencia Reservoir on the hills overlooking the Country Club, two reservoirs (yet to be built) and one large and two small tanks.

Because almost all the financing of the East Side Division was done by the property owners living in the East Side District, it is necessary, for accounting purposes, that the East Side be maintained as a division, otherwise it would be incorporated as part of the San Jose Division, of which, for operating purposes, it is a part.

Pala Reservoir Equalizer

Water from the San Jose Division will flow into the Pala Reservoir, which reservoir will then act as an equalizing reservoir in conjunction with the Cambrian Reservoir and the San Jose system in general. From the Pala Reservoir the water will be elevated to the Pueblo Reservoir and then from the Pueblo to the Penitencia Reservoir.

The gravity system for the Los Gatos Division begins at the Lake Ranch Reservoir. The waters flowing in the Beardsley Creek, and such as are released from the Lake Ranch Reservoir, are diverted through filter galleries back of the dam in the Beardsley Creek, a mile or so from where the Beardsley enters the Los Gatos Creek. From the Beardsley Dam the waters are conveyed through a pipe line to the Madera Colorada Reservoir. The waters of the Lake Ranch and Beardsley Creek are supplemented by the flow of the Cavanee Creek, which also has a dam and filter galleries about a mile east of the town of Alma. From the Madera Colorada Reservoir the water is piped to the town of Los Gatos and allowed to pass through the distributing system to the Mountain Spring Reservoir, in sufficient quantity to supply the demand of the town, the Mountain Spring Reservoir acting as a pressure head.

Any water not needed for Los Gatos, which flows into the Madera Reservoir, is diverted into the flume and becomes part of the waters of the San Jose Division.

The pumping system for the Los Gatos Division consists of pumps at the Los Gatos Reservoir in order that water primarily intended for San Jose can be diverted into the Los Gatos system and an emergency pump installed at the Cambrian Reservoir so that waters from the wells of the San Jose Division can

(*Continued on Page 49*)

METERS & METERING

Use of Current Meters in Hydraulic Field

Growing industrial and argicultural developments insist upon an increasing economic distribution of water. It is this pressure that makes engineers consider improvements in means and ways to effect that distribution. Water current meters have long been used to determine stream velocities, but notwithstanding their long use, meters have frequently surprised their operators by unexpected indications, which gave rise to the question. "When are current meter indications reliable?"

Mechanical current meters can not possibly be 100 per cent reliable. The best of them disturb the original stream flow, to determine the velocity of which is the purpose of meter works. Meter indications are the result of modified, instead of the original stream forces at the meter. They must be erroneous to the extent of the stream-disturbing influences.

Before going any further it must be understood that reliable meter work does not mean accurate meter work. A meter in good order, carefully operated can give reliable indications; whereas, accurate meter work may be expected from an expert operator using a capable meter in a perfectly (uniform and parallel) flowing stream. Many tests have been made to determine the degree of reliability and accuracy of meter actions, but judging from the varying results, the above question is still unanswered.

Efficiency of Current Meters

Tests made at rating stations determine the efficiency of meters. They demonstrate motor actions as influenced by changed meter positions, but they cannot prove the reliability of meter indications, because of the artificial water condition. Tests made in streams and channels by weir discharges have given little satisfaction because of lack of uniformity in stream flow.

While it seems impossible to get results from practical meter tests it remains to define what reliability of meter indications consists of. Reliable meter indications are those that represent the velocity correctly. Therefore, a meter of unfavorable form or size, that changes the stream flow excessively and causes eddies, is not capable of indicating the original stream flow correctly. Reliability of meter indications and work depends to a great extent upon the meter design.

As it is desirable to measure the natural stream flows, they should not be materially disturbed while being gauged, which means that the meter must be small and of a form such as will obstruct the flow as little as possible. Stream flows are not parallel. A reliable indicating meter must be actuated by the forward component of the stream forces and if possible function in accordance with some defined rule or law (cosine). Stream flows are not uniform throughout the cross section of channels which make vertical integration, as a method of stream gauging, desirable. The meter should be qualified for this task. Stream flows are constantly changing for which reason the meter must respond immediately to such changes. Its rotation should should be under complete control of the stream forces.

Fundamental Requirements

These are fundamental requirements for reliable meter indications. They can not be met by vertical meters while the designs of most of the horizontal axis meters are based upon such requirements.

It might be well to explain why the results of either meter type, when operated in high velocity channels, closely agree. It is because the stream lines are more nearly parallel, in which case the stream conditions approach those under which the meters were rated.

On the other hand, why do the results of meter work in low velocities so often disagree, whether they are produced by the same or different types of meters?

Irregular stream flows at low velocities, upon meeting an obstacle in motion, are bound to be considerably disturbed, forming eddies whose influences combine with those of instrumental inertia. It may be readily understood that the forces which actuate the meters in low velocities are vastly different from the natural (original) velocity forces. Under such conditions the meter indications can not be reliable.

Investigates Miniature Models of Arch Dams

(*Continued from Page 17*)

The action of arch dams is a complicated problem, more complicated than the action of arch bridges, because of the fact that arch dams are restrained along the irregular profiles of the foundations and abutments instead of along two parallel sections as in the case of arch bridges. The assumption usually made in the design of arch dams is that part of the horizontal water load is carried by vertical cantilever action, and the remaining part by horizontal arch action, the distribution of loads being based on the criterion that the deflection of the arch elements must equal the deflection of the cantilever elements at corresponding points. The usual procedure in determining the load distribution has been to bring the arch and cantilever deflections together at the crown section of the dam, and then to assume that, for such a distribution, an equally satisfactory agreement of deflections exists at other parts of the structure. During the last few years the Bureau of Reclamation, in preparing designs for costly arch dams, has been continuing the mathematical studies until the arch and cantilever deflections are in agreement entirely around the dam, at from 6 to 10 different elevations and from 10 to 20 vertical cross sections. If the entire water load can be accounted for by the arch and cantilever elements, without producing excessive stresses, suitable allowances being made for temperature variations, the structure is considered safe. If not, the design must be modified until the excessive stresses are reduced to allowable limits.

Study of Test Models

The accuracy of the fundamental assumptions made in the design of arch dams, the effect of variations in shape of cross section on the load distribution, the effect of restraint along the irregular profile of the foundation and abutments on the mathematical formulas used in the design, the effect of movements of bedrock, flow of concrete, temperature variations in the body of the dam, etc., can not be satisfactorily determined by mathematical investigation. It is not known that they can be satisfactorily determined from a study of the action of models. The ideal solution would be an elaborate system of measurements, such as was made at the Sevenson Creek Test Dam, on several full size dams of different design, built in canyons having different shapes of cross section and different rock formations. Such an ideal solution is not practicable because of the excessive cost involved. However, it is believed that an adequate solution can be obtained

through a careful study of the action of small-scale models in conjunction with suitable mathematical treatment, the comprehensive Stevenson Creek Test Dam data, and such experimental observations as it is practicable to secure on other full-size dams.

Use in Boulder Canyon Dam Design

When the experiments on the Stevenson Creek Test Dam model are completed it is proposed to investigate the action of a model of the Gibson Dam now being built on the Sun River project of Montana. Since the valley at the Gibson site has a relatively wide cross section, definitely different from the narrow V-shaped section at the Stevenson Creek site, it is expected that a definitely different load distribution will be found. Computations made in designing the Gibson Dam indicate that approximately three-fourths of the load will be carried by gravity (canti lever) action, whereas, in the case of the Stevenson Creek Test Dam the greater part of the load was carried by arch action.

It is anticipated that the technical data obtained in the experiments with the Stevenson Creek Test Dam and Gibson Dam models will furnish a basis for the utilization of arch elements in designing the Boulder Canyon Dam. It is also expected that such utilization of arch principles in the Boulder Canyon design will result in a comparatively great saving in cost over the tentative gravity designs made in the past. The experience gained in testing the Stevenson Creek and Gibson Dam models should also indicate the proper procedure to follow in building and testing a model of the proposed Boulder Canyon Dam. Doubtless many special problems, which can not now be foreseen, will arise during the prosecution of the work. It is hoped that they all may be satisfactorily solved.

The institution of a comprehensive research program is always the most critical period. Many worthy investigations have been seriously handicapped by getting started in the wrong direction. Although an actual model test has not thus far been made it is felt that definite progress in the right direction has been achieved in spite of the various delays that have been necessary. Plans for the tests have been thoroughly worked out, an experimental pit has been built, a supply of mercury has been obtained, the steel form for the upstream face of the Stevenson Creek Test Dam model has been purchased, advertisement for bids on instruments has been issued, and various miscellaneous supplies have been acquired. It is hoped that the first model dam can be constructed in the near future and that the experimental data obtained will come up to our expectations.

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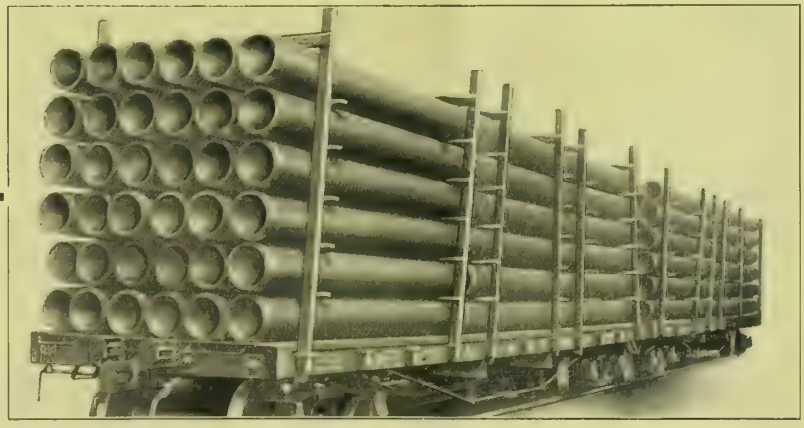

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STORAGE & DISTRIBUTION

Corrosion Tests on Iron and Steel Pipe Made by Bureau of Standards

Rapid Corrosion of Pipe Lines Observed in a Few Soils Where There Were No Stray Electric Currents

By K. H. LOGAN*

In Charge Bureau Standards Soil Corrosion Work

THE origin, purpose and scope of the Bureau of Standard's Soil Corrosion Investigation have been stated too often to require repetition. The following summary of the results of the work as indicated by the specimens removed in 1926 must be considered as a progress report, since less than a third of the total number of specimens which were buried have been examined and because it is probable that as the work continues new factors affecting the corrosion of the specimens will appear. Conclusions at this time must, therefore, be tentative and subject to revision in the light of data to be secured later.

The scope of the work has become so broad that it seems advisable to report on it as five projects, although little can be said concerning any of them.

The specimens which have been in the ground longest are those representing commercial pipe materials. A report on these specimens was made two years ago, after they had been buried from one to two years. Another lot of these materials was removed in 1926 and a report on their condition will be presented at the annual meeting of the American Foundrymen's Association in June. Specimens of other materials also were removed in 1926 and reports on them will be published by the Bureau of Standards the latter part of this year.

Earlier Conclusions Confirmed

In a general way the results of the last examination of specimens of unprotected iron and steel pipe confirm the conclusions† drawn from the examination of the specimens removed two years earlier. Rapid corrosion of iron and steel has been observed in a few soils where there were no stray electric currents. With the exception of high-silicon cast iron, the mechanical properties of which limit its use, no one ferrous material under test has so far appeared superior under all soil conditions. There is a wide variation in the appearance of the specimens from different soils, but usually the corrosion patterns on all of the welded materials from the same soil are quite similar and the differences either in rates of corrosion or rates of pitting are usually small. This leads us to believe that there is an important relation between corrosion and some characteristics of the locality in which it occurs. What this relation is has not been determined but it seems probable that some physical or chemical property of the soil controls the rate of corrosion.

Another result of the investigation is the accumulation of additional evidence that the so-called graphitic corrosion which is frequently associated with stray current electrolysis may occur in the absence of stray currents. Graphitic corrosion products, which are really mostly hydrated ferrous oxide with which is mixed a few per cent of graphite and other impurities occurring in cast iron, are usually formed when corrosion occurs too rapidly for the complete oxidation of the corrosion products, and were found on all the cast specimens which suffered serious corrosion. It can now be definitely stated that graphitic corrosion does not necessarily indicate stray current electrolysis. The distribution of pits over the surface of the specimens varied from one or two per square foot to almost uniform corrosion. From this we may conclude that the form and distribution of the corrosion on a pipe does not indicate whether the soil or stray current is responsible.

Corrode Without Currents

The results of the soil corrosion investigation do not, at present, justify any conclusions as to the ultimate usefulness of any of the materials under test in any of the soils, the relative merits of these materials or the prevalence of corrosive soils. The test has, however, already shown definitely that rapid corrosion may occur without the presence of stray currents and that electrolytic corrosion cannot be distinguished from soil action by the form, character, or distribution of the corroded areas. Additional study of soil corrosion problems should show the extent of the known corrosive soils, produce methods for quickly telling whether a soil is corrosive, and suggest measures for preventing corrosion.

In recent years there have been offered a number of metals and alloys said to be more resistant than steel to corrosion. Samples of two kinds of lead and a number of brasses were removed in 1926.

Lead corroded in fewer of the soils under test than did steel and the depth of the pitting was less in almost all cases. Nevertheless, lead was found to corrode rather badly in a few soils.

At the end of two years little corrosion and almost no pitting have been found on any of the brass specimens although some of the yellow brass specimens have turned red indicating a selective corrosion of the zinc. No tests have been made to determine whether the strength of the alloy has been decreased. Little evidence of galvanic action between brass and lead or brass and galvanized iron screwed together has been observed, and the specimens of bronze welded joints in cast iron show little galvanic action although when the two surfaces are clean there is a considerable difference of potential between them.

Galvanic Action

It appears that the character of the corrosion product determines whether a galvanic potential will result in continued corrosion. This is an important result of the soil corrosion investigation, for a great deal has been written concerning corrosion due to dissimilar metals being placed in contact with each other in the earth. Such contact of metals at slightly different potentials is almost unavoidable, not only because the proper construction of underground lines requires the use of more than one material, but also because such potentials are often the result of impurities, strains, mill scale and differences in oxidation or other surface conditions when the metal used is nominally of one kind throughout. While undoubtedly corrosion may arise from these galvanic potentials, there is a fair chance that it may not continue because of the formation of protective films, polarization or some other change in conditions after the pipe is buried.

Specimens of zinc and also of duralumin showed serious corrosion in two out of five soils in which they were buried. The corrosion of the zinc is of interest in connection with the data re-

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†Trans. American Foundrymen's Assoc., Vol. XXXII, page 144.

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cently obtained on metallic protective coatings, four of which are under test.

Specimens 6 inches by 12 inches of 16-gauge sheet with approximately 2-ounce coatings of zinc on three base metals and two kinds of galvanized pipe have been buried in most of the 47 test soils. Those removed after two years show various stages of deterioration, but as yet the effect of the character of the base metal is not apparent. As in the case with the bare pipe, the galvanized specimens indicate that the rate of corrosion depends largely on soil conditions. In most of the test locations the corrosion of the galvanizing was slight. In a few soils practically all the galvanizing has disappeared and the sheets are rusted or pitted.

In some soils where iron corroded rapidly the galvanized material shows little loss, and in a few locations there has formed on the surface of the galvanized pipe a corrosion product which has much the appearance of varnish. Whether this corrosion product is so continuous as to completely protect the pipe cannot be determined at present. A study of this corrosion product and the conditions under which it forms might lead to the development of a protective coating suitable at least for some soil conditions.

Lead and Lead Coatings

While the specimens of sheet lead showed little corrosion in all but a few locations, so much cannot be said for the specimens of lead-coated pipe. Fifty-six out of 87 specimens removed showed pits of 0.02 inch deep or deeper and in a number of soils the pits were deeper than on the corresponding specimens of unprotected steel pipe. This accelerated corrosion is attributed to galvanic action at points where the lead coating was imperfect. The loss of metal from the lead coated specimens is usually quite small, but the pits are frequently deep and in a few cases there is a hole through the pipe wall. The particular type of lead coating under test, therefore, appears unsatisfactory for pipes which should be leak proof, although it might be suitable for the protection of structures where the maintenance of mechanical strength only is essential.

The Bureau of Standards' tests of bituminous protective coating materials cover only types of coatings applied at the pipe mill or in a pipe yard and do not include certain other materials which may be so applied. While the tests are inadequate on this account the results are interesting and suggestive.

Thin Coatings Unsatisfactory

In general, it may be said that all of the thin coatings applied as dips proved unsatisfactory in a number of soils. They became brittle and rust formed beneath them. The thicker coatings obtained by the use of fabric impregnated with asphalt or coal tar pitch appeared better, but in several instances there was evidence of deterioration of the asphalts. All of the asphalts tested are of the air-blown variety. Whether a natural asphalt would give different results is not shown by the tests.

An important result of the test of bituminous coatings is to show that a coating which stands up well under some soil conditions may fail in other soils.

It appears that protective coatings, like pipes, should be selected with reference to location in which they are to be used. So much has been said recently concerning certain proprietary materials and processes for protecting pipes and so many cases of long life of pipe protected by these materials have been cited that a comparative test of these and several other protective coatings under a variety of soil conditions seems desirable. Such a series of tests would doubtless lead to the improvement of some of the proposed coatings and be of great value to the pipe user who desires to secure a coating adapted to his soil conditions. Probably there is no one best coating, but there may be several which under certain conditions are entirely satisfactory. The problem is to discover where to use and where not to use these coatings.

Laboratory Tests

While waiting for corrosion to develop on the buried specimens, the Bureau has made a number of laboratory tests which deal with corrosion phenomena. The results of most of these tests have been negative. Nevertheless some are of value. We have not been able to associate, chemical analyses of soils with their corrosiveness except under a few conditions. The accelerated corrosion tests which we have tried usually do not check with field results.

Showing the new Adeline Street, (Oakland) factory of the Art Concrete Works.

Art Concrete Works Designs New Style Meter Box

A new type of meter box, which has just been put on the market by the Art Concrete Works of Pasadena and Oakland, was exhibited at the San Jose Water Works Convention. This new style of box, according to an announcement from the company, has several advantages. Instead of having a projecting shoulder on the inside of the box to support the lid, straight wall construction inside gives a larger opening and affords more room to remove or repair the meter without disturbing the box itself.

The round reading lid of the meter box is of ample size to admit light and can be handled with minimum effort. Practically no lid breakage, it is said, will be experienced with a box of this type. The break-away slots have been redesigned and improved. The new boxes flare outward somewhat at the top, thus preventing settling and making it easier to remove them from sidewalk or pavement.

New Modern Factory

The Art Concrete Works have during the past year completed a new and attractive plant at 24th and Adeline Sts., Oakland, which, according to reports, has many modern improvements developed through their 15 years experience in Pasadena. One of the most important, they advise, is the addition of compressed air installation so that all their products are tamped by pnumatic rammers instead of by hand. The new plant has a light stucco exterior finish similar to that of the Pasadena plant, but has a cement floor throughout so that their products may be carried about the plant upon lift truck platforms during the curing period without danger of any chipping or damage necessitating patching.

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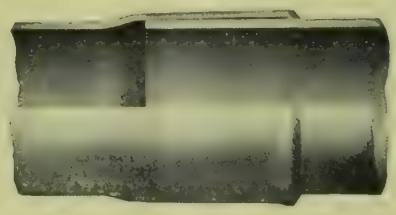

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Novel Design of Power Head for Deep Well Pumping

Apparatus Imparts Perfect Rotary Motion for Pumping Water from Deep Wells

The new Dorward power head, having a perfect rotary motion for pumping water from deep wells with either the single acting cylinder or double acting cylinder of the single rod construction, is now being manufactured for general distribution by the Alamo Engine Co. of Hillsdale, Mich. This apparatus has undergone four years of the experimental stage, in which it has been tested under the most adverse conditions of pumping, from extreme depths in the well combined with heavy discharge pressures at the surface.

The outstanding features of this pump are its extremely quiet operation, the smooth running motion lacking the usual jar and shock common to all side arm, crank action or link acting type of power heads. The lubricating system is fully enclosed and has every moving part dipping directly in oil every revolution instead of depending upon splash or vapor to supply the oil to the operating parts. The mechanical action can be briefly described as follows:

The power applied to the pinion shaft is transmitted through cut gearing to a revolving drum supported on hardened steel roller bearings in each end of the cylindrical housing. This drum has a crankshaft placed eccentric, and equal to one-quarter of the stroke, the head running clear through it and supported on bronze bushings, the front end projecting with a crank equal to one-quarter of the stroke, the rear end fitted with a heavy stub tooth pinion, engaging a fixed internal gear.

This construction causes the crankshaft, while turning with the drum to also revolve on its own axis in the opposite direction, creating a so-called compound motion which develops the straight line motion on the piston rod, free from thrust of any kind and requiring no guide for this purpose. One filling of the proper lubricant in this head will last for at least one year's steady operation.

The power head is fitted with belt tightener for either side allowing close belt drive, can be run in either direction and owing to its compactness and low structure, can be installed in very limited spaces, requiring very little head room. The discharge can be swung in three different directions of 90 degrees.

This pump is distributed by Woodin & Little of San Francisco where it can be seen and will be fully explained to anyone interested. They have been installed in some of the largest public

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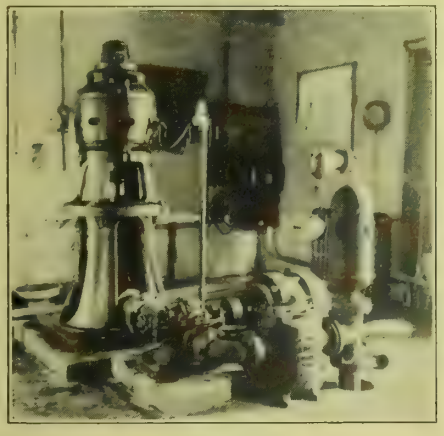
buildings in San Francisco to the entire satisfaction of the engineers in charge,—also one notable instance of installation in one of the Southern California oil camps, is an 18-inch stroke head, operating a 4¾-inch double acting cylinder, placed 500 feet deep in the well.

Efficient Pump Units Developed for Waterworks Plants

(Continued from Page 24)

Several manufacturers are building two pole, 60 cycle motors up to comparatively large sizes which operate with good characteristics, so that 3,500 revolution pumps can be supplied where the conditions warrant. In quite a number of instances this additional speed makes the pumps more efficient.



A direct connected Allis-Chalmers Centrifugal Pump and Motor, designed to operate at 3500 R.P.M. This unit acts as a booster for a Layne and Bowler Deep Well Pumping Unit.

Another type of unit which is becoming very popular among the smaller water works plants, is the gasoline engine stand-by unit for emergency use, in case of failure of the main supply. This type of unit can also be used in isolated communities where there is no electric service available.

Among other recent developments, there has been placed on the market a double suction, multistage pump. This unit is really several single stage, double suction, volute pumps built into a single casing, and has the desirable features of runners balanced against end thrust without the use of any internal balancing devices. It has a high efficiency and considerable flexibility when applied to high head pumping conditions.

W. R. Kepler, hydraulic engineer for the Newport News Shipbuilding and Drydock Co., spent several days at the Minidoka Dam, Idaho, testing the new turbine for unit No. 6 of the Minidoka power house.

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WATER PURIFICATION

De-Aeration of Water for Prevention of Corrosion in Steel Pipe Lines

Description of a Process Installed on 350 Mile Pipe Line in Western Australia where Corrosion Was Particularly Bad.

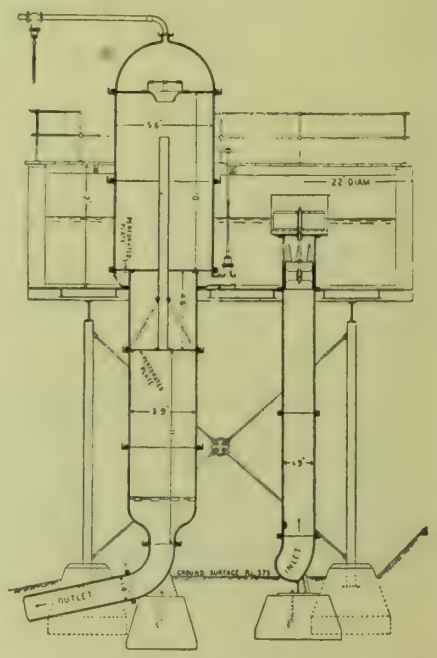
By WALTER K. WELLER

IN 1909 the Western Australian government commissioned a board, consisting of Messrs. A. Binnie, Son and Deacon, Sir William Ramsay, and Mr. O. Hehner, to advise as to the best methods of checking the corrosion of the 30-inch steel pipe line, 350 miles long, from Mundaring to Kalgoorlie. The board found that the essential cause of the corrosion by water is the dissolved oxygen it contains, and that corrosion can be completely stopped by the removal of the dissolved oxygen from the water.

In 1917 a deaerator capable of treating 6,000,000 gallons of water per day was designed by the officers of the goldfields water supply and installed at the Mundaring reservoir in 1917. It consists of two similar units, each capable of treating 3,000,000 gallons of water per 24 hours. The inlet ports of these units, a float controlled valve, screen chamber and overflow pipe, are all situated in an elevated steel tank, 22 feet in diameter and 7 feet deep, supported on steel columns and girders 16 feet above ground level, which, at this point, is 28 feet above the top water level of the overflow tank at No. 1 pumping station. The accompanying cut shows a section of one of the deaerator units and of the float valve; the screen chamber, 5 feet square, which surrounds the float valve, is omitted for the sake of clearness.

Flow Description

The water from the reservoir is delivered by gravitation through the float-controlled valve into the elevated tank, and, after passing through an 8-mesh screen, flows into the two deaerators through openings, of which there are 12 in each unit. Six of these inlet openings in each unit are provided with valves, 5 in. in diameter, and by opening one or more of these the flow through each unit can be varied from 1,500,000 to 3,000,000 gallons daily, in steps of 250,000 gallons. After passing the inlet openings, the water flows into an upper vacuum chamber, through 1-8-inch holes drilled in an annular gunmetal plate, 3-8-inch thick, made in four segments.



There are 2,760 1-8-inch holes in this plate, or 230 for each of the 12 compartments which it covers. The head, forcing the water through the holes, is that due to the atmospheric pressure, say, 34 feet, plus the head due to the height of the water surface in the tank above the level of the holes (3 feet). The pressure resisting the entry of the water is that due to the pressure of the air and water vapor in the vacuum chamber, equal approximately to 2 feet of water. The net effective head driving the water into the vacuum chamber through the 1-8-inch holes is therefore about 35 feet. After impinging on a flat plate fixed near the top of the vacuum chamber, the water falls back and collects in a vessel situated below the level of the perforated annular plate.

The bottom of this vessel is formed of gunmetal plate, 3-8-inch in thickness perforated with 7,500 holes, 1-8-inch in diameter. The water flows through these holes under a head of from 3 feet to 4 feet into the lower vacuum chamber, and thence gravitates to the pumping station. The upper vacuum chamber is provided with a manhole to give access for cleaning out the holes in the upper and lower perforated plates. The gases, disengaged from the water on its passage through the lower vacuum chamber, pass into the upper chamber through a 6-inch pipe extending from the top of the lower chamber to half-way up the upper one. From the top of each upper chamber, a 3-inch pipe controlled by a valve leads into a 5-inch main, 136 feet long, which conveys the extricated gases from both units of the deaerator to a receiver, 12 inches in diameter and 6 feet high, situated in the vacuum pump house.

This receiver serves to make the flow of air in the 5-inch main continuous and separates any water that may be carried in with the gases. The vacuum pump suctions—which are 5-inch in diameter—are connected to the receiver near its upper end, and a drain pipe fitted with an ejector operated by steam is provided, by means of which any water that may accumulate in the receiver can be removed from time to time.

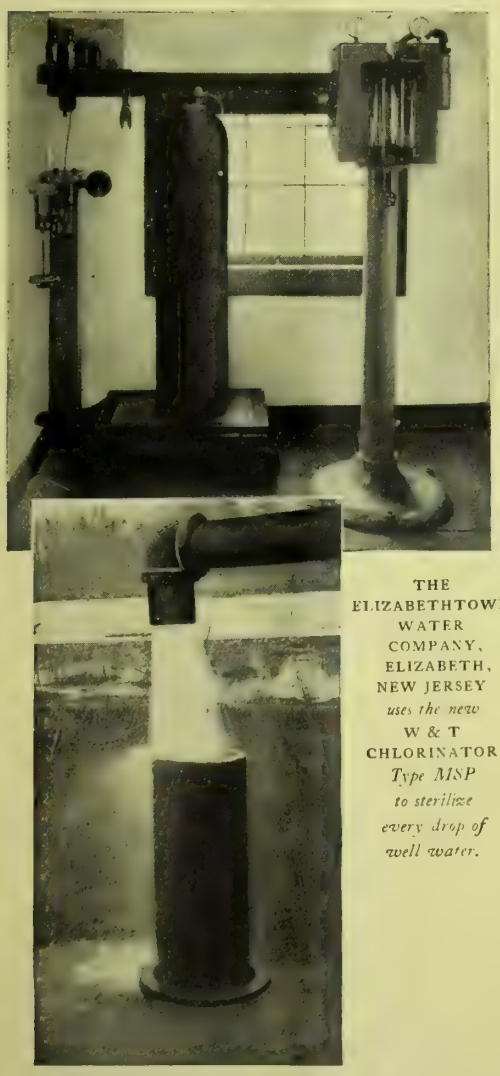
Use of Vacuum Pumps

Two similar straight-line steam-driven vacuum pumps are provided, but only one at a time is worked. Each pump has two air cylinders of 14 inches diameter, working in parallel, and one steam cylinder of 10-inch diameter. The three pistons are fixed on one rod, and the stroke is 12-inch. The usual running speed of the crankshaft and flywheel varies from 120 to 130 r.p.m., and the indicated power in the steam cylinder at the latter speed is 16 h.p. The vacuum maintained in the receiver varies from 28 to 28½-inch of mercury, according to the barometric pressure for the time being, and to the temperature and volume of the water being treated.

The ratio of the vacuum pump piston displacement to the volume of water being treated, when 4,000,000 gallons of water a day are passing through the deaerator and the vacuum pump is running at 120 r.p.m. is 1.3, and, when 6,000,000 gallons a day are being treated with the vacuum pump running at 130 r.p.m., the ratio is 0.94.

Presented February, 1927, at the ... meeting of Institution of Engineers, Melbourne, Australia.

All Well Waters —Should Be Chlorinated!



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PUBLIC HEALTH ENGINEERS are rapidly dissipating the old-fashioned but popular idea that well waters are pure and safe to drink just because they are well waters and come from under-ground sources.

They know that well waters are liable to pollution—that a fissure in the rock or a break in the well casing often permits disease ladened contamination to enter the supposedly pure water—particularly in times of flood.

They know that hundreds of Typhoid Fever Epidemics have been caused by well waters.—They know that the three outstanding typhoid epidemics in recent history—Salem, Ohio—Lansing, Michigan — Santa Ana, California — were all caused by polluted *unchlorinated* well water.

That is why there is a marked tendency toward the chlorination of all well waters —because a properly chlorinated water cannot cause disease — because chlorination will not change the physical or chemical characteristics of the water in any way — because chlorination costing but one cent per capita per year is the cheapest public health insurance.

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After passing through the deaerator, the treated water gravitates to a stand-pipe at the pumping station. From the stand-pipe, the water flows into a receiver, 4 feet in diameter and 50 feet long, to which the three main pump suction pipes are connected. The quantity of water flowing through the deaerator is controlled by means of the 12 inlet valves, and is made slightly greater than the amount being drawn by the pumps. The excess passes through a relief outlet from the main which connects the deaerator to the stand-pipe and flows into a square tank, 12 feet deep, having a capacity of 1,000,000 gallons which was in existence prior to the deaerator being installed. This tank always remains full, and the excess water passes out to waste through the overflow. Any slight variation in the rate of pumping is thus taken care of without the necessity of continually adjusting the regulating valves of the deaerator.

The water from the Mundaring reservoir contains 8 parts per million by weight of dissolved oxygen at 79 degrees Fahr. in the summer and 10 parts at 55 degrees Fahr. in the winter. After passing through the deaerator, the oxygen content is found to be from 0.7 to 1.0 part per million, indicating an extraction of about 90 per cent of the dissolved oxygen. The former figure is obtained when 4,000,000 gallons a day and the latter when 6,000,000 gallons is treated.

Water Distribution

The deaerated water is pumped through a 30-inch diameter steel main, 350 miles long, by a series of seven pumping stations. About one-half of the total water pumped is delivered at Kalgoorlie, where the main terminates, and the balance is drawn off en route to supply agricultural towns and districts through 980 miles of branch mains.

It is found that, after traversing about 30 miles of the main, the residual dissolved oxygen that was not removed by the deaerator becomes absorbed (probably by rusting the metal of the pipe) and the water then has no corrosive action on the steel. If, however, the water is exposed to the air, oxygen is again dissolved and its corrosive activity is renewed.

Under the original lay-out of the works and mode of regulating the flow through the main, plentiful supplies of air were absorbed by the water at various points, but these opportunities for access of air were to a great extent eliminated prior to the installation of the deaeration plant.

Following some of the recommendations of the board previously referred to, the inlets to receiving tanks had been ar-

Pure Water

THE 1907 census registration showed a typhoid death rate of 30.3. The use of liquid chlorine as a sterilizer for water had its beginabout 1908. In 1919, the rate had decreased to 9.2. This represented a saving of lives equal to 21.1 for each 100,000 population or, on the basis of a population for the United States of 111,000,000, the saving amounts to the enormous total of 23,200 lives. In other words if there had been the same typhoid death rate throughout the country in 1920 as that in the registration area for the year 1907, there would have been 23,200 more deaths from typhoid fever than actually occurred. This represents a saving to the country of the enormous total of $116,000,000.

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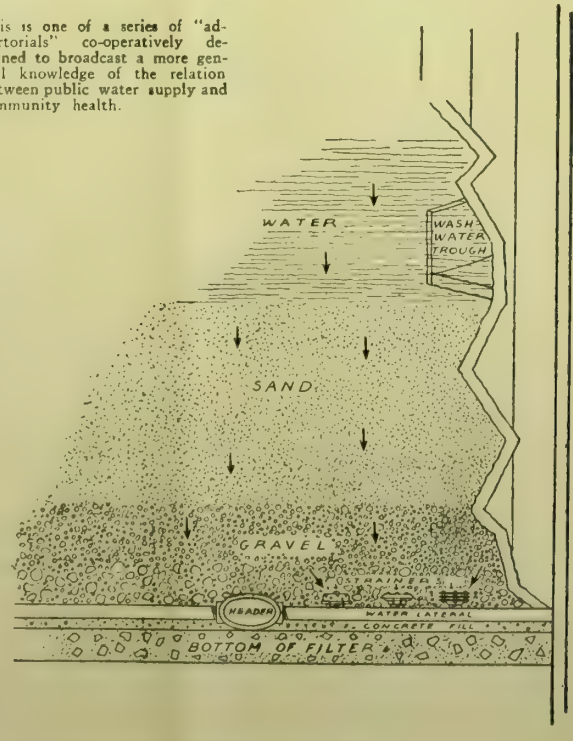

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ranged to discharge near the bottom of the tanks instead of over a bell-mouthed pipe above the surface. Six summit tanks were provided at high points between pumping stations to keep the main full during such periods as the pumps are not working. Floating covers were provided at one of the pumping station receiving tanks, and at three of the summit tanks, to reduce the absorption of air by the water in the tanks. On cessation of pumping at each pumping station, the inlet valve to the receiving tank next ahead is closed in order to conserve the water in the summit tank and so keep the main charged during the period the pumps are not working.

PREVENTING AIR ABSORPTION

The air vessels at pumping stations were provided with an extension at the lower end fitted with baffle plates to prevent the absorption of air by the water passing through the pump, and a special blow-off valve was fitted to each air vessel to ensure that, on cessation of pumping and consequent lowering of pressure in the main, the compressed air in the air vessel shall be discharged into the atmosphere instead of being blown into the main, as was originally the case. Two automatic flow regulators, which were in use at West Northam and at Toorak tanks, and which permitted air to enter the main, were dismantled and hand regulation of the inlet valves to the tanks next ahead was adopted to ensure that these sections of the main should be kept full of water.

Additional measures to reduce the quantity of air absorbed en route include the provision of by-passes round six of the regulating and receiving tanks along the pipe line. At Baker's Hill tank, the by-pass conveys the water past the tank without any exposure to air, the tank being kept full for emergency storage.

At West Northam tank, a by-pass is provided round the tank, and only the difference between the quantity of water reaching and leaving this point enters or leaves the tank, and this difference is kept as small as possible by hand regulation of valves at the inlet to the tank and at the inlet of No. 3 pumping station. At No. 3 pumping station, where a receiving tank of 10,000,000 gallon capacity is provided, the water from the preceding section of the main, instead of flowing into the tank as formerly, now flows into a stand-pipe at the pumping station, and thence to the pumps, only the difference (if any) between the flow to and from the pumping station being drawn from or added to the tank as the case may be.

BYPASS VALVES PROVIDED

The absorption of air at the 1,000,000-gallon receiving tank at No. 8 pumping station, at the 12,000,000-gallon Bulla Bulling tank, and at the 1,000,000-gallon Toorak tank, has been eliminated by the provision of by-passes round these tanks at such levels that water may be pumped direct from No. 7 pumping station to Kalgoorlie without going through the tanks, which are now used for emergency storage only.

The capital cost of the deaerating plant installed, complete with the necessary connections, vacuum pumps, etc., was $25,272, and the annual charges for interest and sinking fund may be taken at 7 per cent, equivalent to $1,769 per annum.

The operating cost is made up of wages for attending to vacuum pumps and deaerator, fuel used to generate steam to drive the vacuum pumps, additional fuel used at No. 1 pumping station because of the additional height the water has to be pumped due to the loss of head (68 feet in passing through the deaerating plant, and cost of testing, etc. These items, it is estimated, amount to $4,714 per annum, and the total annual cost of deaerating the water is therefore $6,480. The quantity of water pumped at No. 1 pumping station in a year is now approximately 1,200,000,000 gallon and the cost of treatment is thus $5.40 per 1,000,000 gallon.

Plans Presented to Irrigate Sacramento Valley Tract

Project Would Supply Water to 277,000 Acres and Create Electric Power

Plans for an irrigation project embracing a gross area of 277,000 acres in the Sacramento Valley in California have just been presented in a report to the Bureau of Reclamation, Department of the Interior, by Engineer W. R. Young, the Bureau has stated.

The project would include the construction of the Iron Canyon storage dam, 152 feet high, near Red Bluff, Calif., and a main canal some 120 miles long from a division dam just below Red Bluff to a point about 16 miles south of Colusa.

Except for a 7,000-acre tract east of the river near Red Bluff, the irrigable area stretches along the foothills of the Coast Range west of the Sacramento River in Tehama, Glenn, and Colusa Counties for an air-line distance of about 100 miles, with an average width of four and one-half miles. The full text of a Bureau statement on the project follows:

The investigation on which this report is based was undertaken by the Bureau of Reclamation in cooperation with the State of California and the Sacramento Valley Development Association. Con-

struction of a storage dam at the Iron Canyon site was proposed in 1920 in connection with a high-line irrigation canal planned to divert water directly from the reservoir. On account of the high cost per acre estimated for this development, further studies of a low-line canal with incidental power development were urged, resulting in the present report.

The water supply for the project would be derived from the 10,000 square miles of Sacramento River watershed above the reservoir site. The dam as planned would be a concrete structure raising the water surface 152 feet above low-water level and impounding 1,121,900 acre-feet of water, sufficient to cover the 60 square miles of land area in the District of Columbia to a depth of 29 feet.

This water when released from the reservoir would pass through the turbines of a 110,000-horsepower hydroelectric plant to be built at the foot of the dam, generating electrical energy to be sold for irrigation pumping and for power and lighting purposes throughout the lower Sacramento Valley. It is estimated that the returns from the sale of this power would return the investment in reservoir and power plant within 20 years, besides providing a surplus which might be applied to repaying the cost of the main canal and distribution system. The total estimated cost of the project is $56,000,000.

Successful Automatic Primer for Centrifugal Pumps

Centrifugal pumps no longer need to be submerged in order to keep them primed, but can be placed in the most convenient location above the water line with all parts instantly accessible. The only portion requiring submersion is the suction line and float, the patented automatic primer taking the pump out of the sump and placing it where it is easier and cheaper to care for.

The advantages of this more convenient arrangement are at once apparent. The pump operates in the efficient horizontal position rather than in a submerged position at the end of a long vertical shaft. No vertical thrust bearings are required as the pump is horizontally direct-connected to the motor and therefore operates with a minimum of vibration.

The pump-and-primer unit is compact, self-contained and efficient. It costs less to install than the ordinary type vertical submerged centrifugal pump and is less expensive and troublesome to maintain. The primer is entirely automatic and dependable for remote control and intermittent service, operates on any suc-

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tion lift and requires no manual operation or attention.

This apparatus, which is patented, consists of a simple tank and piping system by which the pump is automatically primed whenever the pump comes to a standstill. The primer tank is divided into two parts, one above the other. When the pump is operating, the liquid is discharged through the upper tank, which is then left filled with water. When the pump stops, the liquid in the upper tank runs backward into the pump and lower primer tank again, thus filling them with water. This drives out the air, flushes the line and reprimes the system.

When the pump starts it draws in liquid from the lower tank of the primer. This creates a vacuum in the lower primer tank which in turn draws in water continuously from the suction line. The priming operation is repeated every time the pump is shut down.

Automatically primed centrifugal pumps appeal particularly to repair men and those who come in direct contact with pumps because such units are cleaner, more efficient and more accessible than the ordinary type submerged pump. Repairing a submerged pump, as is well known, is generally a nasty job which no self-respecting mechanic likes to tackle.

For isolated pumping plants, irrigation and any remote control where pumps must operate on a suction lift, this primer pumping unit is ideal. Primers operate on any suction lift, against any head and are furnished for any desired capacity.

Important Installations

Many important installations are giving satisfaction after years of use. Among these may be mentioned the Portland Dry Docks, Portland, Oregon, the Dredge Clackamas, owned by the Port of Portland, the sewage system at Longview, Wahington, a town entirely built by the Long Bell Lumber Co., near Seattle. The application of primer-equipped pumps to railroad uses everywhere is particularly interesting and successful, as dependable pumping and water supply is one of the railroads' greatest problems.

Sewage disposal also furnishes a large field for these units and architects and builders who have used these units for this work state they would never go back to the vertical submerged pump.

The automatic primer is a much needed improvement on centrifugal pumps. It removes the greatest limitation on this otherwise efficient type of pump, making it equal or superior to ordinary suction pumps and capable of an even greater variety of uses. The field for centrifugal pumps has suddenly been widened.

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Copper Service Pipe for Domestic Water Lines

House Piping, Sprinkling Systems, Meter Connections, and Similar Service Lines Now Being Installed with Copper Pipe

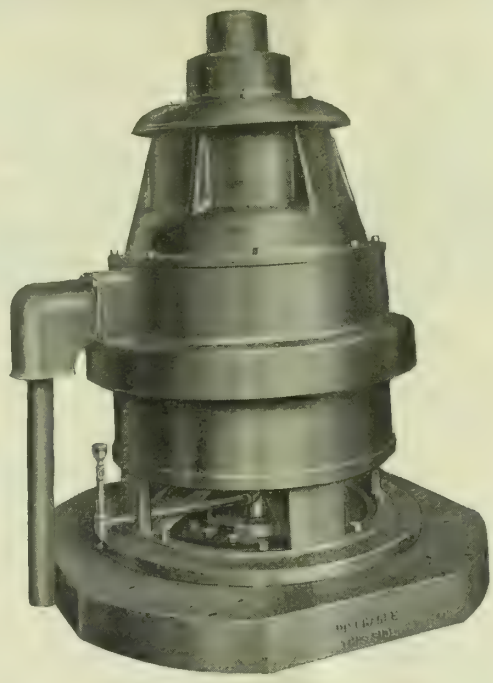
By P. B. ANDREWS

Copper has been used by man for approximately 10,000 years, almost every race of people having used it and always with the same lasting results. Today copper objects are being found where other materials have decayed or corroded into obliteration. Engineers and chemists concede it to be the best material to resist corrosion under ordinary conditions, and it is unquestionably the best material for water supply piping, but due to its relatively high cost it has never before been developed to any extent for such a purpose.

The exploitation of iron and the rapid development of the iron and steel industries have placed ferrous metals to the front. Piping can be purchased at such a low comparative cost as to offset any advantages that can be gained by having the same weights and dimensions duplicated in copper. However, with the advent of thinner walled copper pipe on the market with flared connections in place of screwed threads the difference in installed costs to the consumer is slight in comparison to the life of the pipe. It is now cheaper in the long run to install copper where endurance is desired.

Waterworks engineers have been quick to see this which accounts for the hundreds of cities now using copper service pipe. Thirty-six California cities are now using it while many others are contemplating such installations.

Briefly, the pipe is a thin gauge, seamless and pure copper pipe. It has inside diameters corresponding to iron pipe sizes such as ½-in., ¾-in., 1 in., 1¼-in. 1½-in., and 2-in. The pipe being too thin to thread is flared into a metal to metal compression joint with the specially designed fittings. The ¾-in. pipe will withstand 1000 pounds hydraulic pressure, the joints many times that amount. The material makes a service extremely easy to install, besides providing an elastic and flexible supply pipe that has very rugged qualities. Under ordinary soil conditions it should last for centuries.



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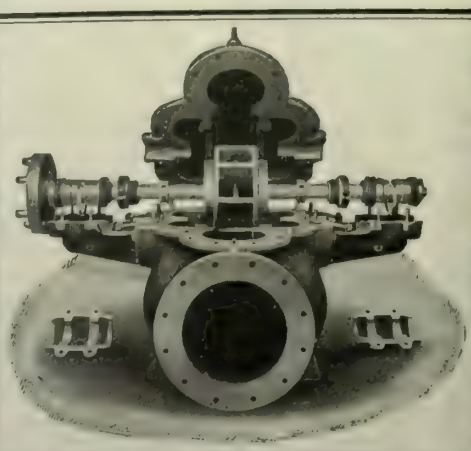

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Rule of Adverse Possession Declared by Court

Continuous use of a ditch not required in order to establish title.

In the case of Ephraim Willow Creek Irrigation Co. vs. Olson et al., 258 Pac. Rep. 216 (Apr. 27th, 1927) the Supreme Court of Utah on the question of adverse use, states:

"In order to establish title by adverse possession . . . to water rights, use need not have been continuous every month of the year, if users maintain their ditch open and visible, so that persons of ordinary intelligence could recognize it as a ditch used for the purpose of conveying water."

However, the Supreme Court held that "the presumption is against the acquisition of title by adverse use" and reversed the judgment remanding the cause for a new trial solely on the question of adverse use.

Idaho Court Rules on Seepage Water Appropriation

Interference by drainage district does not destroy such right.

It appears that respondent had utilized a certain dry gulch to convey water turned into it from certain irrigation laterals. When first used the gulch contained only run-off water from rains and snows. Later and gradually, as the irrigating canals in the vicinity were enlarged and more land was put under irrigation, surface waste and seepage waters appeared in the gulch and materially augmented the flow therein.

Later a drainage district was formed, which in its construction work used the gulch as a drainage canal, and the trustees bring a suit to enjoin respondent from taking water from the gulch, claiming that respondent had no right to appropriate seepage or waste waters and therefore all such waters belonged to the drainage district.

In the case of Sebern et al. vs. Moore, 258 Pac. Rep. 176 (June 27, 1927), the Supreme Court of Idaho declares the right of appropriation of seepage or waste waters in that state to be as follows

"We conclude that surface waste and seepage water may be appropriated under the provisions of C. S. Sec. 5562, subject to the right of the owner to cease wasting it, or in good faith to change the place or manner of wasting it, or to recapture it, so long as he applies it to a beneficial use. His control is not dependent upon continuous actual possession, and in the absence of abandonment or forfeiture of his right to its use, he may assert his right, which is not affected by his once having applied it to a beneficial use. . . . Such water having been once appropriated, upon the construction of a drainage canal that destroys the ditch through which it was carried, if susceptible of being identified, may be reclaimed in the drainage canal by the prior waste appropriator, where, in so asserting his right, he does not substantially injure the drainage works or materially interfere with the control or management of the drainage system. Where there has been no appropriation fo waste or seepage water prior to the construction of the drain in which such water collects, said water is in the possession of the owner of the drain, and is therefore not subject to appropriation."

Irrigation District May Stop Payment of Warrants

Mandamus against treasurer to enforce payments of warrants does not lie after payment had been ordered stopped.

In the case of State vs. Dilworth, as treasurer etc., 258 Pac. Rep. 246 (July 18, 1927), a writ of mandate was sought against the treasurer by reason of her refusal to pay certain warrants of the Red Lodge-Rosebud Irrigation District. Her defense was that payment of the warrants had been ordered stopped by the Board of Directors. In upholding the refusal of the trial court to issue the writ, the Supreme Court of Montana, states:

"The respondents' answer to the alternative writ expressly stated that she (treasurer) had been directed not to pay the two warrants held by the relator, and that payment of them had been stopped by the district. If this were true, if the power which had ordered her to pay the money had rescinded the order, her right to pay it ceased, and this would be a complete defense to relator's application for a writ of mandate to compel her to pay. . . . Counsel for relator next advances the argument, as we gather it, that under the terms of the contract . . . the construction fund was in reality deposited with the County Treasurer in trust for him and that, irrespective of the action of the Board of Directors in issuing and stopping payment on the warrants in question, the treasurer should be required by mandamus to turn over to him the amount shown to be due by the engineer's estimate . . . section 3977 Revised Codes of 1921 designates the county treasurer . . . as the custodian of all funds belonging to the district, and provides that he shall pay out said funds upon the orders of the Board of Directors. . . . Under the statutory provisions relative to the deposit of its funds with the county treasurer and the method by which they may be disbursed, an irrigation district has no power to place them in trust for the benefit of third persons or disburse them in any manner except that prescribed. . . . A public corporation in this State has no power to act unless its authority to do so is conferred by a statute or necessarily implied therefrom. . . . Therefore, even if the parties to this contract attempted thereby to establish a trust of the funds in question with the relator as beneficiary, the attempted arrangement would be invalid for want of power on the part of the irrigation district."

Idaho Company Has Unique Plan to Conserve Water

Court rules against by-laws providing for cumulating storage rights to water.

The Salmon River Canal Co. of Idaho acting as the operating company on a Carey Act project adopted a By-Law reading as follows:

In order to encourage the greatest practical economy by individual water users from year to year, each water user will be entitled to carry over for use the following season, as individual or personal storage, such water as has been alloted to him but not used. . . . .

An action was brought to enjoin the carrying out of this rule and in the case of Glavin vs. Salmon River Canal Co. 258 Pac. Rep. 532, (July 28, 1927), the Supreme Court of Idaho holds that the rule was not consistent with the reasonable use of water contemplated by the laws of appropriation of that State. The theory of appellant was that the rule tends toward conservation of water, and gives the careful user an advantage, to which he is entitled, over the more prodigal users. . . . In reply to this contention the Court states:

"Viewing the question with reference only to the considerations urged by appellant, there is considerable reason in support of the rule . . . but the By-Law in question as it now exists seems to admit of many other contingencies. . . . Under the rule, it is entirely possible for a landowner to allow his lands to remain entirely idle, thus carrying over all of his water supply . . . and to still maintain his right to hoard the same as against other users who could and would have made beneficial use of the water in the year of its original storage. . . . It is entirely possible also, for one owning a water right to speculate with it, rather than to make a beneficial use of it, allowing his land to lie idle, and holding the water as individual storage until a season when he can dispose of it to some needy water user at a price exorbitant or otherwise. . . .

It is against the public policy of this State, as well as against express enactments, for a

water user to take more of the water to which he is entitled than is necessary for the beneficial use for which he has appropriated it. . . . Public policy demands that, whatever be the extent of a proprietor's right to use water until his needs are supplied, his right is dependent upon his necessities, and ceases with them.

We think the holding of the trial court, that distribution of the water in the reservoir cannot be lawfully based upon the By-Law as it now exists, was proper.

U. S. Supreme Court Refuses to Review the Herminghaus Case.

The Riparian Theory of Lux vs. Haggin firmly fixed on the State of California.

The appeal of the Southern California Edison Company to set aside the decision of the California Courts enjoining it from diverting into storage reservoirs for power purposes the waters of the San Joaquin river was refused consideration by the United States Supreme Court on October 6th.

Counsel for the company attacked the injunction, claiming the company acts as an agency of the government, under licenses granted by the Federal Water Power Commission, and asserting that should the decision of the California Court stand, the federal government would be unable to carry out the federal water power act in many of its substantial features.

Appellants consumed all the time allotted them for argument in trying to establish that federal questions were presented which brought the case within the jurisdiction of the court.

At the conclusion of the argument the court notified the riparian owners along the river, who had won in the state's court, that it would not be necessary for them to reply, indicating, under its practice, that it had concluded no federal question was presented upon which it should pass and that the case must be dismissed for want of jurisdiction.

Drainage Aid Bill Proposed

The National Drainage Association proposes to submit to the next Congress a bill providing for the establishment of a revolving fund from which drainage boards can borrow to meet their annual payments on drainage bonds and interest, depositing with the Treasury Department the refunding bonds of the drainage districts without interest and payable over a long period of years. According to a statement sent out by the Association, 1,500,000 of the 6,500,000 farms in the United States have drainage or are in need of it, so that a bill such as they ask will, says the president of the Association, W. H. Dick, benefit the farmers on 25 per cent of the farms in every state of the Union.

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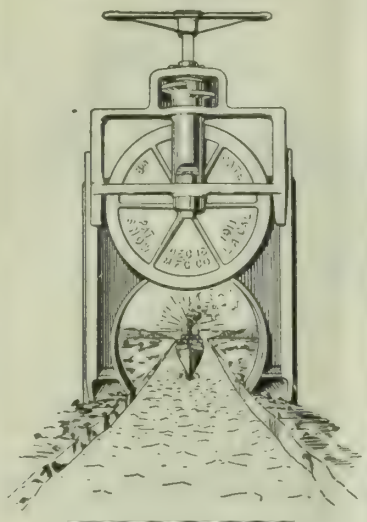

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Scientific Development of Irrigated Farms

(*Continued from Page 22*)

water resources of the State and the information thus acquired has fixed a definite goal for ultimate irrigation development. Not only this, but State Engineer Bailey has outlined a comprehensive plan in following which progressive construction and utilization may take place. I doubt very much if any undertaking of like extent and cost in any state of the Union is likely to result in so much clear gain.

Modern Machinery Aids Agriculture

Regarding the saving of labor on the farm, my memory goes back to a time when conditions in rural communities in Eastern Canada, where my boyhood was spent, were quite different from those of today. Muscular effort was then at a premium. We had to do nearly everything by hand. Potatoes were planted between the stumps by a hoe made by the village blacksmith and the same implement was used later to form a hill of turf and soil around each plant. Wheat was harvested with a sickle, threshed on the barn floor with a flail, cleaned of chaff by a fan and carried to the nearest gristmill on the back of a horse. Butter and cheese were made in the kitchen. A woman's deft fingers spun the wool and made it into garments. Even shoes and straw hats were home made.

In the course of time, however, the mechanic, the inventor and the village blacksmith devised many labor saving implements. The sewing machine multiplied woman's efforts. The mowing machine replaced the scythe and swath and did the work of ten men, the reaper replaced the sickle and the cradle and plowing was made more rapid by the sulky and the gang plow.

These improvements speeded up farming but a time soon came when something more was needed to supply foodstuffs for our expanding nation. It was at this juncture that the engineer became the ally of the farmer. By the use of steam he converted the slow and uncertain sailing vessel into a fast and dependable ocean carrier, replaced the slow moving wagons by trains propelled by locomotives, and transformed the creaking old grist mills into giants of electric energy. In short, the influence exerted by the engineer on agriculture has been so pronounced and far reaching during the past twenty-five years that the Nation has not had a chance to adjust itself to the new order of things.

Engineer Responsible for Development

This to my mind has been one of the causes of the depression in agriculture. We have been trying to adopt new ways of doing things while clinging tenaciously to old methods which are fast becoming obsolete. It has been difficult for the Nation to realize that each electric or gas motor installed on the farm is going to free a number of manual workers for some other calling. About thirty million people in this country are dependent on Agriculture and many bemoan the fact that in the past decade two-thirds of a million have quit farming to go into cities or find work in shops and factories. Under prevailing conditions this is a logical transfer and there is no necessity to worry over it. Is it not rather true that this hegira from the farm to the city and factory is but the advance guard of many millions who will follow them? The lazy, incompetent and unfit must be weeded out of our rural life in order that the energetic and progressive may succeed.

Considering the present trend and the activity displayed in making use of inanimate power on the farm to take the place of animate—that is, humans, horses and mules—it is reasonably safe to predict that in the near future twenty million people will produce more soil products at less cost than are now produced by thirty million. It is also reasonable to conclude that such a transformation would be to the best interest of the Nation as a whole. If such a change is looming high on our horizon, each one of us must act the part of a Napoleon in his own work and territory to plan aright the coming campaign.

More Technical Training Needed

There is urgent need of training the young farmers—those who are now in the grammar schools—to use their hands as well as their heads. They should devote a certain number of hours three days in each week at the carpentry bench, the blacksmith forge, and the machine shop. Then, when they advance in their studies, they should be well grounded in physics, chemistry and mathematics, which will pave the way for a combined course in agriculture and engineering in case they can complete their education by taking a college course.

Again, a large percentage of the sixty-five million farms in this country must be overhauled, reconstructed, and equipped with modern appliances. At present most of them are misfits. They were developed for the most part in the old days when the hoe, the scythe, the single furrow plow, and the horse or mule team were the common implements and power used. The small farm was best adapted to such equipment, but in switching from mules to tractors, and from manual labor to motors and machines, a much larger farm is needed.

A 480-acre Iowa farm if well equipped will produce more corn at much less cost than can be produced on six 80-acre farms on which the motive power is derived from horses and mules. Similarly, a 160-acre orchard on the Pacific Coast can be equipped in such a way that it will produce more fruit at less cost than can be produced on ten 16-acre orchards. The big farm of the near future, however, to be successful will require on the part of the operator broader training and more experience. A knowledge of agriculture alone will not suffice; he must needs understand machinery, farm economics, transportation charges, and world markets.

San Jose Water System at A. W. W. A. Convention

(*Continued from Page 29*)

be pumped back into Los Gatos should there be any necessity for its being done.

Gravity Flow from High Line

The High Line Division has a gravity system, the supply of which comes from the Aguaje del Monte, and which is sufficient for practically seven months of the year. During the summer months or time of heavy draught, the water is pumped from the Mountain Spring Reservoir into the Rinconada Reservoir.

The Saratoga Division is supplied from the Saratoga Creek in the bed of which have been installed the usual concrete dam and filter galleries, the waters flowing from the galleries to the Saratoga Reservoir about a mile south of the village, from which they enter the distributing system. For itself, Saratoga has no pumping system at all, but is directly connected with the High Line so that in case of any emergency the consumers in Saratoga can be taken care of by the High Line Division.

Normal Gravity Flow

Under ordinary conditions all of the winter water and the greater part of that needed for the summer consumption is obtained from the gravity system and normally the flow of water is from the southwest to the northeast, that is to say, from the Santa Cruz Mountains through the town of Los Gatos and the City of San Jose to the East Side. Under abnormal conditions the flow can be reversed and the water forced from San Jose back to and through Los Gatos. In fact, in August, 1924, water was pumped from the wells in and near San Jose to the Madera Colorada Reservoir above Los Gatos and into the Rinconada Reservoir for use of the High Line and the village of Saratoga.

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OVERHEAD IRRIGATION

SUPPLY PIPE SYSTEMS FOR SPRINKLER INSTALLATIONS

BECAUSE of its closely limited cross-section and the roughness of its bore, iron pipe offers appreciable resistance to the flow of water. The smaller the pipe the greater is the resistance; and if the pipe size remains the same, a greater resistance is offered to a large flow than to a small one. The resistance to flow offered by a pipe can best be measured by the loss in pressure which results when water is forced through the pipe. If 100 feet of 2-inch pipe be fitted with a pressure gauge at each end, and a stream of water be forced through that pipe, the gauge at the outlet end will record less pressure than the gauge at the inlet end. This loss of pressure measures the resistance offered by the 100 feet of 2-inch pipe to the flow of the quantity of water which was forced through. If the pipe were 200 feet long, the difference between the gauge readings would be twice as great. No simple proportion exists between the loss in pressure and the quantity of water.

Many engineers have endeavored to determine the pressure losses resulting when certain sizes of pipe are used to convey varying quantities of water. Tables have been prepared from numerous experiments by which it is possible to foretell with some degree of exactness what losses in pressure may be anticipated under given conditions of diameter of pipe, length of pipes, and quantity of water.

In designing sprinkler layouts, the problem becomes more complicated, for in the main pipe line the quantity is being constantly decreased as the laterals are reached. And in the laterals, the flow is being constantly reduced as successive sprinkler heads are supplied. The pipe connecting the last two sprinkler heads on a lateral should be only large enough to carry the quantity required for a single head. The section between the main and the first sprinkler must carry the whole flow necessary for the lateral.

There is no short cut toward the intelligent design of such installation. Each lateral must be considered in turn, usually starting with the one most distantly removed from the source of water and pressure. Pipe sizes are determined for each section between successive sprinkler heads. If a manufacturer recommends, for the sprinkler head made by him, a working pressure of 15 pounds per square inch, then the pressure at the foot of the stand must be enough in excess of 15 pounds per square inch to lift the water to the top of the stand and deliver it at the required pressure. One pound per square inch represents the pressure exerted by a column of water 2.31 feet high. If a stand is 12 feet high, the pressure at the base of the stand must exceed the required pressure for the operation of the head by 12 divided by 2.31, or 5.2 pounds per square inch. A pressure of 20.2 pounds per square inch, as measured on a gauge at the foot of the stand, would be required before satisfactory operation could be secured.

The pipe joining this last stand in the example given above with the one next to it must be large enough to deliver the quantity of water required by a single head through the length of pipe represented by the distance separating the stands, and must provide a pressure of 20.2 pounds per square inch at the end of the line. The next section must be similarly determined. In this case, the quantity required for two heads must be considered, since the last head and the next to the last must be supplied.

Data on Pipe Sizes

The pipe section leading from the main to the first sprinkler on a line must be large enough to deliver the entire flow for the lateral. The pressure requirement at the intake of this lateral must be smaller than that which is available at the source, since there is necessarily some loss of pressure in the main connecting the source of water with the head of the lateral.

A main designed to supply sufficient pressure for the most remote lateral is usually large enough to supply sufficient pressure for nearer ones. Ordinarily smaller pipe sizes can be used in laterals close to the source than in those more distant. Effort spent in a close determination of pipe sizes, so that every pound of available pressure is utilized, is repaid by a smoothly operating system and low first cost.

The design of a system for the use of portable stands is less complicated than that for a permanent installation. However, the same principles apply and the same care should be used. The greatest saving can be gained through the careful design of the main line, since small reductions in diameters of large sizes are reflected in relatively large reduction in costs per foot of pipe. The principles involved in designing the underground distributing main are, of course, common to all types of sprinkling installations.

Prevention of Corrosion by Proper Pipe Covering

(*Continued from Page 23*)

surface in such a way that the outer layer seals over the edges of the spirals of the inner layer. All air pockets are eliminated by this method and the felt covering is less likely to be abraded during application.

The pipe sections are generally rolled in sawdust or grain hulls, after covering, to prevent adhesion, or an additional wrap of express or kraft paper is applied during the machine process, for this purpose.

The width of the felt covering varies according to the size of the pipe and the method of application. For the Wieland wrapping machine, as illustrated, the following widths of pipe covering are recommended:

3-4-inch pipe—3-inch width pipe covering.

1-inch pipe—3-inch width pipe covering.

1 1-4-inch pipe—3-inch width pipe covering.

1 1-2-inch pipe—4-inch width pipe covering.

2-inch pipe—3 1-7-inch width pipe covering.

3-inch pipe—4-inch width pipe covering.

4-inch pipe—5 1-7-inch width pipe covering.

6-inch pipe—7 1-5-inch width pipe covering.

8-inch pipe—9-inch width pipe covering.

The felt used in the wrapping process must be of exceptional quality with high tensile strength, carefully saturated and coated with a suitable grade of asphalt. Pioneer Pipe Covering has been especially developed for this purpose by the Pioneer Paper Company. A specially tough and pliable rag felt is used and this is saturated and coated with over 150 per cent of its own weight of an asphaltic material selected for high resistance to weathering and temperature change. This covering serves to armor and reinforce the asphaltic coating, for which the same company has developed the product known as "Rubbertex." Pioneer Rubbertex is refined from selected California asphalts and is processed to secure a solid, impenetrable coating of great flexibility. It is generally known that most asphalts possessing a high melting point become brittle at low temperatures and chip easily. The range of temperature susceptibility of Rubbertex is such as to secure a very high melting point, assuring that the material will not become fluid at high temperatures, but especial care is taken to secure a low brittle point. In testing for the brittle point, metal may be coated with Rubbertex and then frozen in ice. Even at this extremely low temperature, the metal may then be bent and twisted without cracking or chipping the Rubbertex coating.

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Pioneer Pipe Covering applied by approved method has given excellent service over long periods of time under typical Pacific Coast conditions. The uniformly satisfactory results obtained are exemplified by the experience of the South Montebello Irrigation District, who recently installed thirteen miles of pipe protected by Pioneer Pipe Covering, for their pressure system. Experiments were carried on by this District, on sections previously laid, and it was found that Pioneer Pipe Covering which had been in service for sixteen years had preserved the pipe in as good condition as when first laid, while uncovered pipe showed marked deterioration.

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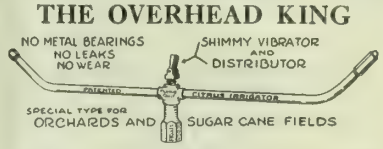

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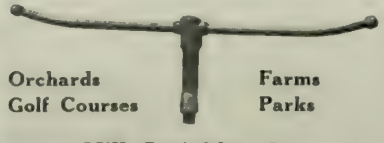

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SURVEY *of* HYDRAULIC DEVELOPMENT

A summary outline of developments contemplated on Western projects which have been announced during the month

Irrigation Development

CORVALLIS, ORE.—A very large irrigation project is being planned for the Willamette Valley, where 500,000 acres will be placed under artificial irrigation.

POLSON, MONT.—A tentative contract for the Flathead Irrigation District has been made, and is now in the hands of John F. Truesdell, Supt. of Irrigation, who is located in Los Angeles.

SANTA BARBARA, CALIF.—Engineer Henderson has recently stated that the support of virtually all property owners in the Santa Inez Valley has been obtained for the irrigation project being contemplated for that region. One of the features of the district is the construction of a 70 mile road from San Lucas to the "Punch Bowl" at Lompoc.

PRESCOTT, ARIZ.—The entire issue of the Chino Valley Irrigation District bonds were purchased by a Denver house for $76,500. Proceeds from the sale of these bonds will be used in the construction of the Willow Creek dam, to supplement the water that is impounded in Lake Watson.

HAVRE, MONT.—Rehabilitation work on the Hammond Irrigation Project has been started by C. A. Darby, of Klamath Falls, Ore. This work is being financed by J. R. Mason Company of San Francisco, Calif. It is contemplated that there will be installed two pumping plants, both using Diesel engines as prime movers.

ELLENSBURG, WASH.—Work on the high line canal of the Kittitas project is progressing rapidly, according to reports. It is contemplated that the peak will be reached early next year. It is now hoped that two more contracts will be let this fall, one for the building of the north branch canal, and the other for the diversion dam and headworks at Easton. It is also planned to let the contract for the South Branch Canal next spring, and at the same time the contract for the building of the Yakima river tunnel or siphon will be let.

PHOENIX, ARIZ.—An agreement has been reached between the Salt River Valley Water Users' Association and the Verde River Irrigation and Power District for the development of an 80,000 acre tract of land, which will contemplte complete irrigation and power development. The initial cost of this project is estimated at $5,000,000, and the ultimate cost at $23,000,000. The money will be raised by a bond issue, secured by the lands of the Verde and Deer Valleys, the market for these bonds having already been arranged for. The Salt River Valley Water Users' Association will undertake this new development scheme, on account of their powerful organization.

SALT LAKE CITY, UTAH.—Sealed bids, subject to the conditions contained herein, will be received until 2 o'clock p. m., October 25, 1927, and then publicly opened, for furnishing labor and materials and performing all work for construction, comprising earthwork and structures, on the Weber River Division, Salt Lake Basin Project, Utah. The work includes the Echo Dam, and grading and structures for the relocated branches of the Union Pacific Railroad and the Lincoln Highway around Echo Reservoir, and is located near Echo, Utah, on the Park City Branch of the Union Pacific Railroad.

The principal items and the approximate quantities involved are as follows: 40,000 cubic yards stripping for embankment; 2,250,000 cubic yards excavation; 1,700,000 sta. cubic yards overhaul; 14,000 cubic yards concrete in structures; placing 750,000 pounds reinforcing steel; placing 2,500 linear feet concrete culvert pipe, and 1,000 linear feet corrugated metal culvert pipe; installing 880,000 pounds of structural steel and other metal work; and constructing 15,000 linear feet of highway guard rail and fence.

This invitation for bids does not cover the purchase of materials, which are to be furnished by the Government. Materials furnished by the contractor, and those furnished by the Government are described in the specifications, which will be a part of the contract.

Performance shall begin within thirty (30) calendar days after date of receipt of notice to proceed and shall be completed within four hundred and thirty (430) calendar days for the work covered by Schedule 1, and within eight hundred and seventy (870) calendar days for the work covered by Schedule 2 from that date.

Copies of the standard forms and of the specifications may be obtained from the Bureau of Reclamation at Salt Lake City, Utah; Denver, Colorado; or Washington, D. C.

Reservoirs and Dams

YAKIMA, WASH.—Work on the municipal reservoir has been stopped because it is charged that the performance of the work is not according to specification.

WENATCHEE, WASH.—Hugh L. Cooper, a New York contracting engineer of international reputation, has applied a second time for a permit to build a large power plant on the upper Columbia River in the Pend Oreille country. The project would consist of a large dam, power house, and transmission lines. It is contemplated to install 12 50,000-horsepower units, six of which would be placed during initial construction period.

CROCKETT, CALIF.—A confidential survey has been made investigating the feasibility of a large dam to be constructed across Carquinez Straits, which would convert Suisun Bay into a fresh water lake. A report of this survey has been made by Walker R. Young, U. S. engineer, and has been filed with State Engineer Hyatt. One of the proposed sites that received the most attention was that from Bullshead Point to Army Point, on the line of the proposed Southern Pacific railroad bridge.

Reclamation and Drainage

HOLBROOK, ARIZ.—Definite action to effect lasting relief from the flood menace that confronts the city yearly was recently taken, when the city council voted to submit the matter to the county board of supervisors. It is contemplated that there will be constructed a drainage canal from the mesa to divert the flood waters into the river east of the city.

Waterworks

BERKELEY, CALIF.—It has been recommended that a new water well be drilled to provide water for the Albany Park community.

PALO ALTO, CALIF.—The city will soon vote upon a bond issue of $45,000 for the purpose of providing a water system for the colony east of Cooley Avenue.

LOMITA, CALIF.—A vote is to be taken by the residents of the city for the issuance of $107,000 in bonds to provide a new water works system.

RIVERSIDE, CALIF.—At a meeting of the common council and board of public utilities, plans were discussed for the construction of a 12,000,000 gallon reservoir to match the present reservoir on Linden Street.

YAKIMA, WASH.—Reports on the proposed electrical development of the pumping plant on the Wapato project have been submitted by Barry Dibble, according to L. M. Holt, supervising engineer.

CENTRALIA, WASH.—Work has been started upon the new 5 million gallon reservoir. The excavation is practically completed, and the contractor is now shaping the side walls.

SAN PEDRO, CALIF.—Petitions are being circulated in Harbor City which contemplate the formation of a county waterworks system, replacing the water system of the W. R. Hollingsworth water company. It is estimated that a new system will cost in the neighborhood of $300,000.00.

OAKLAND, CALIF.—The city will soon vote for the issuance of $26,000,000 in bonds for the purpose of purchasing the properties of the local distributing system, or building another system. This distribution system will be operated in conjunction with the East Bay Municipal Utility District.

Holmes-Manly Cracking Plant of the California Petroleum Corporation recently completed at Watson, California.

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SANTA PAULA, CALIF.—According to R. H. Jamieson, engineer for the state division of water rights, a survey has been started upon the water resources of the Santa Clara Valley, which will require approximately three years to complete.

PORT TOWNSEND, WASH.—An aerial survey is being made of the area surrounding the Port Townsend District for the purpose of assisting the engineers in locating the best possible routes for the new pipe line to be built from Big Quilcene to the city.

SACRAMENTO, CALIF.—The proposed bond issue for the Silver Creek project has been defeated by the voters of the city. The Silver Creek project was one of the outstanding schemes that have been submitted to the city during the past few years for the purpose of a clean and clear water supply. Original reports estimated that this project would have cost the city in excess of $40,000,000, ten million dollars more than the Los Angeles aqueduct. It is the history of such projects as this one to continue to crop up repeatedly from year to year, until there has been a final solution by the city. It is the opinion of many engineers of Sacramento that before the Silver Creek project is allowed to become a reality, there will be another project placed before the voters to take water from the American River in the vicinity of Folsom.

Unit Bids

CENTRALIA, WASH.—A contract for 504 feet of 8-inch cast iron pipe has been let to the Pacific States Cast Iron Pipe Company. The price was $1.44 per foot. Bids for laying this line are now being taken by the city council.

PETERSBURG, ALASKA.—Bids of the Westinghouse Electric & Manufacturing Company and the Pelton Water Wheel Company were accepted by the city for the provision of a new hydro-electric plant. The Westinghouse bid was $3,587.40 for a 500 K. V. A. generator, and the Pelton bid $6,480.00 for a 650 horsepower water wheel.

GARDEN GROVE, CALIF.—Dimmitt & Taylor, 159 E. 58th St., Los Angeles, were awarded contract by Garden Grove Storm Water District, Aug. 16, at 11.5c yd. for (1) excavation of a trench 12-ft. wide and 8-ft. deep, about 8500 ft. long, (2) excavating and placing of material along the present levee, 1200 ft., (3) the construction of fills across trench to be excavated, at intervals of 600 ft., these cross-fills to be 6 ft. in width at the top. Award will probably be made Aug. 16. Other bids: Griffin & Tyler, 13.4c; Steele Finley, 13.5c; Geo. Mitchell & Co., 13.9c; Schweitzer Bros., 14.9c; C. C. Murdy, 15c; Wells & Bressler, 15c; L. A. Decomposed Granite Co., 15.3c; Callahan Constr. Co., 17c; R. Johnson, 18c; J. G. Donovan & Sons, 19c; Kreider-Chase Constr. Co., 19.8c; Huntington Park Constr. Co., 25c; C. G. Willis & Sons, 26c.

SANTA ANA, CALIF.—Bids received by city Aug. 22 for furnishing 600 metres during a period of one year, are:

National Metre Co.—$12 ea., $7200, also an alternate of $5400 for the lot.

Hershey Mfg. Co.—(1) $10, (2) $15, (3) $22, 75c per set of connections, $1.10 alternate; $40 ea., and $60 each for flanges.

Badger Metre Mfg. Co.—(1) $9.25, (2) $9, (3) $8.75, (4) $8.75.

Neptune Metre Co.—(1) $10.75, (2) $10.50, (3) $10, (4) $15.75, (5) $15.50, (6) $15, (7) $16.10, (8) $15, (9) $23.10, 10) $22, (11) $40, (12) $60.

Calif. Metre Co.—600 at $7.75 without couplings, $8.25 ea. with couplings; 1200 ¾-in. brass metre couplings, 49c ea. set, or 24c each coupling.

Worthington Co.—(1) $9, (2) $8.25, (3) $7, (4) $6.75.

Bids taken under advisement one week.

TRACY, CALIF.—Bids received by Banta-Carbona Irrigation District for lining the canals with Gunite or concrete are:

(1) Cement Gun Construction Co., 58 Sutter St., San Francisco, 11.5c sq. ft. concrete lining for laterals, 10.5c sq. ft. main canal.

(2) Manning & Baldwin, 485 14th St., San Francisco, 13¾c sq. ft. for Gunite lining for all work.

(3) John N. Kristich, Knightsen, Calif., 14¾c sq. ft. for hand placed laterals 5 and 6; 10c sq. ft. for main canal.

Bids were taken under advisement until Aug. 17. W. Schlossman, secretary.

LOS ANGELES, CALIF.—Monolith Portland Cement Co., 1306 Bartlett Bldg., Los Angeles, submitted low bid to county supervisors Aug. 22, at $2.07 bbl. for 38,000 bbls. Portland cement in sacks, f. o. b. cars at mill. This firm submitted a bid of $2.58 bbl. for same f. o. b. cars, San Dimas, the same price as offered by the other bidders. The bids follow:

Monolith Portland Cement Co.—Proposal 1: (1) 38,000 bbls. in sacks, f. o. b. cars at mill, $2.07 bbl.; (2) 38,000 bbls. in sacks, f. o. b. trucks at mill, no bid; Proposal II: 38,000 bbls. in sacks, f. o. b. cars San Dimas, $2.58 bbl.; (2) same f. o. b. trucks San Dimas, no bid; Proposal III: (1) 14,000 bbls. in sacks, f. o. b. trucks at Puddingstone Dam site, no bid, (2) 17,000 bbls. in sacks, f. o. b. trucks, Channel warehouse in San Dimas, (3) 7000 bbls. in sacks, f. o. b. trucks, warehouse at Puddingstone Channel Diversion Dam Site, no bid.

Southwestern Portland Cement Co.—I, (1) $2.26, (2) $2.54; II, $2.58, no bid on other items.

California Portland Cement Co.—I, (1) $2.30, (2) $2.54, II, (1) $2.58, no bids on other items.

Riverside Portland Cement Co.—I, (1) $2.30, (2) $2.54, II, (1) $2.58, no bids on other items.

A New Grouting System for Concrete Dams

San Francisco Company Perfects System for Making Concrete Dams Watertight

It is a well known fact that all concrete has a natural shrinkage. Masses of concrete in such structures as retaining walls and dams will crack when shrinkage takes place, and unless precautions are taken to localize cracks, say from 40 to 60 feet apart, where, and in such manner as not to endanger the entire structure (in the case of arch dams) not only great leakage but possibly complete failure of the structure itself may result.

So long as the cracks remain open the dam will not carry the water load on the arch, and as a horizontal arch it must therefore deflect downstream to a point where the arch becomes continuous from buttress to buttress before it will support the load imposed upon the structure.

There has been devised a new and economical method of providing means for grouting contraction joints which is very simple to install, and produces a 100 per cent exit for grout after shrinkage has taken place. It consists of placing light sheet metal half pipes against the forms in each alternate block as the dam is poured. When the forms are stripped, a like half is attached to the first half, imbedded in the concrete face of contraction joint. These pipes are installed vertically, about 6 feet apart in the contraction joints and are connected to a feed pipe at the base of the dam, extending outward on the downstream face.

After the chemical heat has passed out of the mass concrete the contraction joints will then have opened up from one quarter to as much as three-eights of an inch. After a full season has passed and the dam has been subjected to the full water load at least once, the joints should be grouted, preferably during the cold season of the year when contraction of the entire structure is at its maximum and preferably when empty, or nearly so.

Metal grout stops are provided to prevent exit of grout on downstream face of dam along contraction joint, and the metal water stops usually placed in dams prevent exit on the upstream face. A grouting machine is then connected to the pipes at bottom of downstream face of dam, and at first, water is allowed to completely fill the space between the contracted faces and until it over-runs at the top, then followed with a thin solution of water and cement, which is gradually thickened with cement, or cement and sand, if separation of the faces is very great, until the heavy grout appears at the top of the dam, then the grout valve at the base of the dam can be shut off and the grout allowed to set. In ordinary dams it requires from one-half to one hour to complete this process per joint.

The system of using the split pipe insures a perfect job of grouting, first because the grout travels in a metal lined chamber, which does not absorb any of the water from the grouting fluid, and secondly because as shrinkage becomes complete the two halves shrink with the concrete leaving a 100 per cent exit on both sides for the grout to pass through and fill the entire space between the faces.

The use of this grouting system is not confined to thin arch dams, but can also be used in massive dams of gravity type. especially those which are curved in plan. It is recommended for installation in all dams where possibility of leakage may develop at a later date, primarily as a precautionary measure.

In case of straight gravity dams the factor of safety is increased due to the positive beam action produced by grouting, and at the same time producing a

water tight joint. For this benefit alone it is worthy of its cost.

There are good reasons for assuming that a water tight dam will remain safe for a longer time than a leaky one.

Three Ministries Control the Czech Water Supply

The water supply in Czechoslovakia is handled by three ministries. In accordance with an agreement among themselves, the Ministry of Public Works deals with the water supply of larger towns, the Ministry of Agriculture deals only with the water supply of rural communities, and the Ministry of Health exercises a certain measure of control in both cases by giving or refusing grants-in-aid for the proposed projects. This department maintains an experimental station for water purification and sewage disposal.

Inspection of public water supply systems is carried out by the district health officers who report to the provincial administration. According to a recent investigation by the Ministry of Health, there were 1678 central water supply systems.

The Ministry of Public Works and the Ministry of Health are responsible for the building of sewage disposal plants according to the same basis as for water supply systems. A recent investigation by the Ministry of Health showed a total of 610 sewage disposal systems of which 454 are storm water, 131 combined, and 25 domestic sewage with treatment plants.

Irrigation Districts Meeting

The next meeting of the Irrigation Districts Association of California will be held at the Hotel Fresno, Fresno, California, on Thursday, November 10, 1927, at ten o'clock. Among the many important questions to come before the meeting will be that of conducting and financing the campaign for Assembly Constitutional Amendment Number 27, relating to riparian rights. The constitution of the Asociation provides that any director, officer or attorney(or all of them) may represent the district, and the executive committee urges that every district be represented at the coming meting.

Andrew Weiss, former superintendent of the North Platte project, and at present resident engineer on the Don Martinez project of Mexico; Jesus Oroposa, superintendent of reclamation, national committee of irrigation of Mexico; and A. E. Kocher, assistant chief of agronomics, spent several days on the Carlsbad project, New Mexico, recently.

Methods of Water Right Evaluation Under Discussion

(*Continued from page 18*)

water supply or other adequate substitute.

(i) A possible higher valued alternative use for the water.

(j) The capitalized value of net earnings of the project above operating expense and normal interest return on the investment in the physical plant.

VALUE OF DEVELOPMENTS

The bearing of most of the above considerations upon the value of a water right is too obvious to require comment, but a brief further discussion of some of them may be desirable. Referring to item (d) it would seem that while the amount that was legitimately expended in securing the water right would not necessarily fix its maximum value, it would normally fix the minimum value that should be allowed. The word "normally" is used because if the conditions surrounding the business were such that it was impossible to earn a fair return, regardless of rates, and such instances can be cited, then the water right might have no value at all. The item (e), as listed affords another criterion of value. If the value, for ordinary purposes, of the land required to utilize the water right, be deducted from the actual price paid for the land, or if it be deducted from the value of the land for ordinary purposes multiplied by the average "public utility factor" that obtains in the district, in connection with real estate purchases, then the remainder may be regarded as one measure of the value of the water right. This, however, is not deemed a very rational or dependable method of water right valuation because of the uncertainties and the fortuitous circumstances that effect the "public utility factor." In many instances the land has no value at all for ordinary purposes.

PROSPECTIVE VALUATION

Respecting item (f) it may be said that the status of the project, as to the extent of its development and the character of its market, must be reflected in the value of the water right, though it is believed that these factors would be more fully and more properly reflected in "Development Cost" and "Going Concern Value" if the intangible elements of value in a property were segregated instead of being combined into a single item as is so frequently done. While a developed project with good markets for its product would tend to give substantial value to a water right, no court would be inclined to concede a material present value to a water right on account of a prospective future market unless that market was definitely assured and reasonably close in point of time.

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In connection with item (g) which indicates that the magnitude of the water supply in relation to demand, effects the water right value, a distinction between intrinsic value and commercial or market value must be recognized.

In our semi-arid States, for instance, irrigation water has intrinsic value because agriculture would be impossible without it. Even though the results of this agriculture are highly profitable, it does not necessarily signify that the water right is of high commercial value. If the available water supply is in excess of possible demands, and is obtainable from the State without cost other than nominal filing fees, then manifestly the water right proper could have no great commercial value for no one would pay a high price for that which he can obtain practically for nothing. Such value as was warranted by the net profits from the agriculture served would be reflected mostly in the land and to the extent that it was reflected in the stock of the ditch company, the value of the latter, in excess of that represented by physical plant investment and development costs, would more properly attach to "Going Concern Value" and to "Franchise Value" than to water right value. If, however, there was not an abundance of water for future or other requirements then the water right would properly absorb a greater portion of the excess value referred to above.

VALUE OF ALTERNATE RIGHTS

The cost of the next best available water supply or other adequate substitute and the possible higher-valued alternative use of the water, referred to in items (h) and (i), not only afford distinct bases for determining the value of a water right but they may, in certain cases, become the controlling considerations. Certainly they would have application in dealing with water supplies for private industries, and, in connection with public utility properties, they would ordinarily at least fix the maximum allowance that could be made for the water right value. If the water right may appreciate in value, or attain maximum value, from these considerations then a logical corollary would be that if in the future, through changed conditions in stream run off or through new scientific developments, a substitute may be provided at lesser cost, then the value of the old plant would depreciate and this loss in value would also in part be reflected in the water right.

The most fundamental consideration, the one that has the most general application, is that defined in item (j), to-wit:

"The capitalized value of net earnings of the project above operating expense and normal interest return on the investment in the physical plant."

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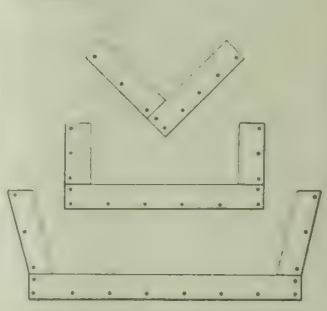

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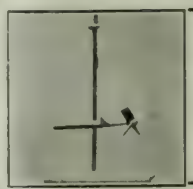

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The capitalization of the excess net earnings referred to above measures not the value of the water right alone but of all those elements classed as "intangibles." If there is no such excess, actual or prospective, then, from an investment standpoint, no value could be assigned to the water rights or other intangibles and the allowed value for a property would need be assigned wholly to its tangible elements.

Intangibles are frequently lumped in a single item because that may suffice for the purpose in hand but for any refined valuation they should be segregated and particularly so when dealing with the specific inquiry of the value of a water right or any other single intangible. This lumping of intangibles tends to confusion and not infrequently this lump sum is expressed wholly as a water right value when such may not be the case at all. The intangibles may include "development costs," "going concern value," franchise value, water right value, etc. The first two are things apart and rather definitely determinable. Franchise value and water right value, however, may sometimes be confused but each individual valuation case will usually afford some rational basis for segregation.

As applied to private industry the logic of capitalizing excess net earnings as a basis for determining water right values can hardly be questioned. It may also be correct as applied to a public utility, depending on the terms of the franchise under which the utility is operating, and particularly if the valuation case is one in which the rates and earnings of the property are found to be fairly definitely fixed, regardless of the method by which those rates may have been arrived at. This, in a sense, begs the question, as respects those public utility properties, for which, in theory at least, the rates depend upon the rate-base rather than the reverse and for rate making purposes in such cases a regulatory commission would need employ some independent method of arriving at the water right value. This, however, opens up too large a field for present discussion.

All of the above considerations and methods of determining water right values may have application in certain cases and none of them have universal application to the exclusion of the others. They may lead to quite different results and the one that should control depends upon local conditions and upon all the circumstances surrounding the particular case in hand. There is too much tendency on the part of appraisal engineers to adhere to rigid rules in valuation work, some adopting that method which always yields a high valuation and others that which always makes for a low valuation.

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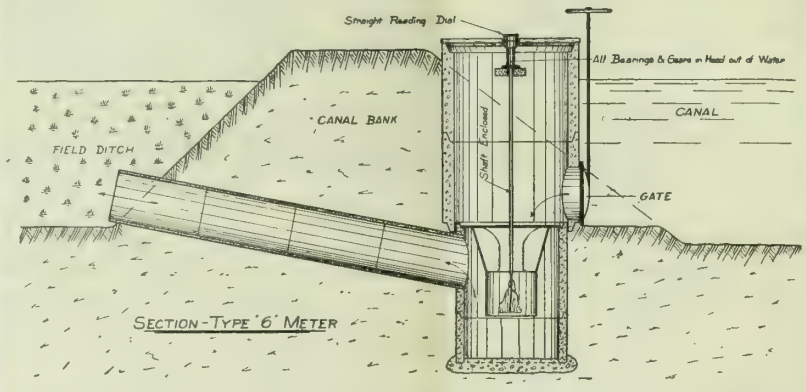

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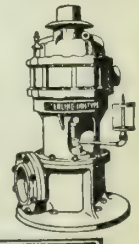

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WHO'S *WHO* AND WHO'S *WHERE*

IN THE WORLD OF HYDRAULICS

Personal Notes and Impersonal Observations About Men You Know

William Lehman, rodman, and B. A. Hall, assistant engineer, at American Falls Dam, have been transferred to the Owyhee project, Oregon.

Dr. Kurt Schneider, of the agricultural college at Ronn-Poppelsdorf, Germany, visited the Yakima project, Washington, during September to obtain information on irrigation farming.

Master Sergeant Dahlgren, of the United States Army, was on the Yuma project recently in connection with aerial photographs that were being made of the Colorado River.

Prof. O. L. Waller, engineering dean of the State College of Washington, and H. W. Lawler, general superintendent of the Utah Construction Company, made a recent visit to the Gibson Dam, Sun River project, Montana.

A. T. Hastings, Pacific Coast manager of the Dorr Company, left Los Angeles early in September for the East where he spent a few days at the company's main office in New York before leaving for Europe on business for the firm.

M. T. Clemans, president of the Florence-Casa Grande Water Users' Association, with Mrs. Clemans spent two or three days recently at the Coolidge dam site, Carlos, Arizona, and while there made a thorough inspection of the work going on.

Charles A. DeKay, engineer draftsman of the U. S. Reclamation Service, has been transferred from the Denver office of the Bureau to the field office at Stony Gorge, Orland project, California.

Willis A. Slater, who has been in charge of experimental work for the Committee on Arch Dam Investigations, with temporary offices in the Boylston Engineering Building, Los Angeles, is returning for an indefinite period to his home office with the Bureau of Standards, Washington, D. C.

Paul G. Redington, the new chief of the U. S. Biological Survey, with headquarters in Washington, D. C., made a recent trip to Klamath Falls, Oregon, relative to the question of reflooding the Lower Klamath lake. Mr. Redington is well known on the Pacific Coast, having been in the forestry service in California and neighboring states for more than twenty years.

PAUL G. REDINGTON
Chief U. S. Biological Survey

Mr. Redington, who is a graduate of Dartmouth and the Yale Forest School, first entered Federal forestry work in California in 1903. In 1916 he was appointed district forester of the Southwestern District, with headquarters in Albuquerque, New Mexico. In 1919 he returned to California as chief of the 18 national forests of that state, was appointed assistant forester, with headquarters in Washington, D. C., late in 1926, and has recently been made chief of the Biological Survey.

George C. Imrie, asistant engineer of the Reclamation Service, formerly office engineer at American Falls, has been appointed inspector of work on the bridge over the American Falls Dam.

J. B. Bond, former superintendent of the Boise project, Idaho, who is now connected with the J. G. White Co. on irrigation work, was a recent visitor at the project office.

Representative N. J. Sinnott, of Oregon, spent several days on the Vale and Owyhee reclamation projects recently for the purpose of learning their latest developments so that he may press their needs at the next Congress.

President and Mrs. Coolidge paid a visit to the Belle Fourche project, South Dakota, on September 1. The President was presented with a miniature gold irrigation shovel, emblematic of the wealth to be dug from the fertile Belle Fourche valley when irrigation is available.

A. J. Wiley, consulting engineer of Boise, Idaho, sailed from Boston, Mass., in October for India in connection with plans for the construction of several high dams contemplated by the Provincial Government. Mr. Wiley expected to be absent from the United States on this assignment until February, 1928.

Miles Robinson, assistant superintendent of the Ventura, California, water department, has been appointed superintendent to succeed the late Edgar Orton. Mr. Robinson will carry out the plans of his predecessor in completing the badly needed water system improvements.

S. O. Harper, general superintendent of construction, spent two days recently on the Newlands project, Nevada, principally in connection with an inspection of the Truckee Canal tunnels, which are to be repaired this fall and winter. Mr. Harper was accompanied by Project Superintendent Stuver and the entire district board.

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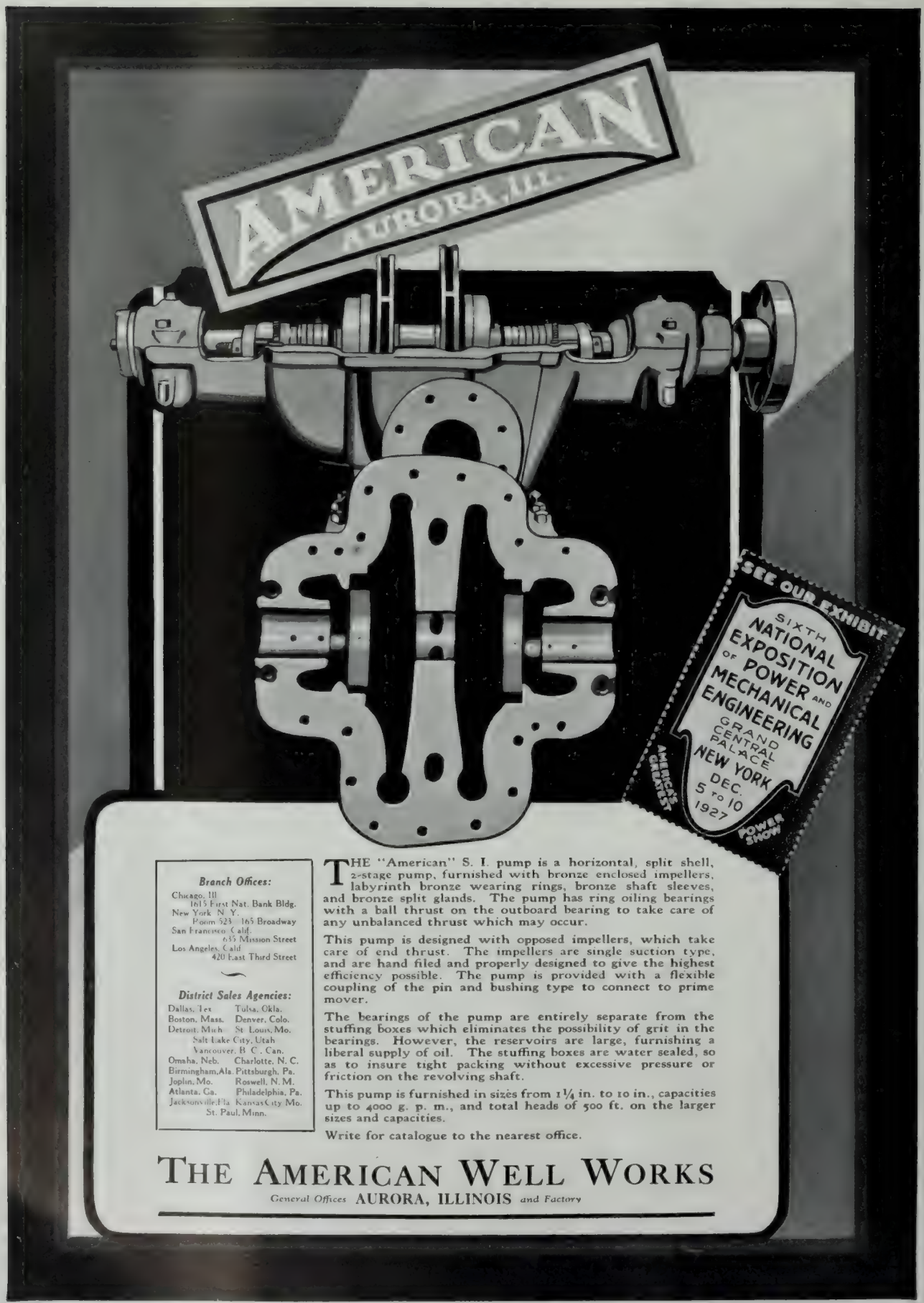

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"Western Waterworks" Begins on Page 25

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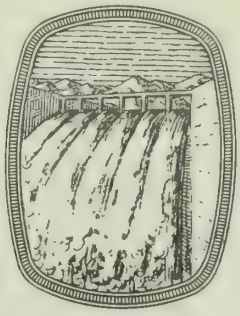

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An Active Winter Season

IT IS customary for construction activity in the hydraulic and irrigation fields to slow down somewhat during the winter months, particularly in those districts where work is likely to be hampered by climatic conditions. However, reports show that, where conditions will permit, there is a tendency to speed up operations this season rather than to slow them down. Along the entire western slope, for example, there is evidence of greater activity, plans for future projects are being formulated, and greater interest is being taken by all those directly concerned with the allied hydraulic industries.

Construction upon the Coolidge dam, in Arizona, is progressing at a more rapid rate than at any time heretofore. Additional equipment has been purchased by the general contractors, workmen are being worked in special shifts, and more yardage is being handled per twenty-four hours than at any other time since ground was first broken. A group of engineers acting in a consulting capacity recently made an extensive survey of this project, formally passed upon the foundations, and ordered procedure with concrete operations. This group consisted of Major-General W. C. Langfitt, representing the United States government, Louis C. Hill and Fred Noetzli, well known consulting engineers of Los Angeles.

New Federal Projects

Word comes from Washington that steps already have been taken to have a new Boulder Canyon dam bill ready for the next session of Congress. Representative Swing, Republican, of California, co-author of the Swing-Johnson bill that failed during the last session, is responsible for this new measure, which, according to Swing, will embody all of the features of last year's bill. At the same time, Chairman Smith of the House Irrigation Committee, which has jurisdiction over such legislation, announced that he was prepared to bring the bill before the committee as soon as it was introduced in the House. He expressed the hope that all seven states in the Colorado River basin who are interested in prospective legislation would reach an agreement on the matter by the time it comes to the attention of the committee.

Plans are progressing within the United States Bureau of Reclamation for immediate action upon the Owyhee-Vale project of Oregon. In calling a conference on land settlement, Commissioner

"Western Waterworks" Begins on Page 25

Mead takes a timely precaution against repetition of mistakes made on earlier government projects. Oregon will profit greatly by making good on the Vale and Owyhee projects, or will lose heavily should they fail. Repayment by settlers of the monies expended upon these projects is the only means by which these funds of the Bureau of Reclamation can be replenished, in order that they may be reinvested in other projects waiting development. Oregon has many such projects in view, and is not, at the present time, in a financial position to disregard the aid of the federal agency.

Contracts for the construction of the new $1,600,000 industrial water supply system for Aberdeen, Washington, have just been let, which indicates some of the progress that is being made in the Pacific Northwest. Washington is a most progressive state, and it is safe to predict that more hydraulic development will take place within that state during the next few years than in any other section of like area in the entire west. Among the projected developments may be listed the Columbia River Basin project, the Skagit River project, the many developments of the Bureau of Reclamation, power plants along the Columbia River, new industrial water supply systems for many of the more progressive cities, and numberless kindred operations.

Red fir and red cedars beside a country road in Washington State.

An Ambitious Arizona Project

Plans fo rthe erection of a storage dam on the Upper Gila River, Arizona, as a unit of the Coolidge dam project are being considered as a main feature of a huge co-operative irrigation project to serve the farmers of the Franklin Irrigation district in Greenlee county, the Gila Valley irrigation district, in Graham county, the Indian lands in Pinal county, and the Casa Grande lands. The proposed storage dam would serve the two first named irrigation districts.

In brief, the plan embraces one district on the Gila from Verdin, New Mexico, on the east, to Casa Grande on the west; the projects to be served by two storage dams and the water apportioned to the respective districts as their rights may entitle them, either by stipulation or by court decision. The cost of the entire project, or projects, would likewise be apportioned, based upon the acreage within each district.

What the result of these preliminary negotiations will be is now problematical, but the proposition has merit provided the details can be worked out to the mutual advantage of all parties concerned. It is admitted that a storage dam on the Upper Gila would be an asset to the Coolidge dam at San Carlos. The water users of the Upper Gila have been delayed in proceeding with their storage dam in view of the law suit filed by the Indian department to adjudicate the water rights on the Gila.

Word comes from Utah that the government has awarded contracts totaling $1,512,067 for the relocation of the tracks of the Union Pacific Railroad and the construction of the Echo Dam on the Salt Lake Basin Reclamation Project of Utah. It was explained that the re-location of portions of the railroad tracks and highway would be necessary because of the flooding of certain areas

Sheba's Land to Blossom

The success that American engineers and builders are having in their own country has become known to other nations, and recently American industry, backed by American dollars, has undertaken the economic development of the realm of the Queen of Sheba. A $20,000,000 contract for the construction of a dam across the Blue Nile near Lake Tsana, negotiated between the Abyssinian government and the J. G. White Corporation of New York. This is described as the opening step in an ambitious program for the cultural and material reconstruction of the ancient nation.

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Economic Importance of Forested Areas in Promoting Natural Water Conservation

Statistics Show That There Have Been Greater Run-Off Fluctuations from Watersheds After Forest Depletions Have Occurred

By HUGO WINKENWERDER
Dean College of Forestry, University of Washington

ALTHOUGH we are especially interested in water conservation for irrigation purposes the topic assigned me is at this time one of much broader and more general interest because of the disasters wrought by the recent floods of the Mississippi Valley and the still more recent ones of New England. Forests and flood control are before us today as matters of the most vital importance to the economic welfare of the country and much of what I have to say concerning the relation of forests to water conservation for irrigation purposes will have a direct bearing on their relation to flool control.

I want to preface my remarks by stating that I shall give you a summary and brief analysis of the established facts. Perhaps no other subject is as much misunderstood as this one and that by persons who should know better—engineers and foresters. Opinions relative to the influence of forests on rainfall, temperature, humidity, and water conservation, are about as diversified and for the most part as inaccurate as opinions concerning changes in the weather. Almost everyone, whether he does so consciously or not, believes he is considerable of a weather prophet. I venture to say that although many in attendance at this meeting are highly trained scientists you all jump at conclusions based on insufficient data every time the status of the weather during the next 12 or 24 hours is of special interest to you. In like manner nearly every intelligent person has some opinion concerning the influence of forests on climate, floods, and water conservation. More often than not that opinion is based on insufficient and sometimes wholly erroneous knowledge of the basic influencing conditions. So many, however, are the factors that play related parts in these influences and so great is the difficulty of observing them with precision that it is not at all surprising to find a very considerable divergence of opinion. Foresters who are insufficiently informed have, in their great enthusiasm to popularize forest conservation, over-emphasized the importance of this question to such an extent that engineers who were no better informed have had a tendency to discredit the whole subject.

Causes of Mis-information

With the large developments in irrigation, hydro-electric power, and the problem of flood control this question is now one of such vital importance that, as stated in the language of Mr. Raphael Zon, Director of the Lake States Forest Experiment Station, "there is no room for professional partisanship and the people have a right to demand from forester and engineer alike a frank and dispassionate analysis of the facts." Let us analyze the probable causes of mis-information.

The most important of these undoubtedly are to be sought in our failure to take into account all of the influencing conditions. The difference in precipitation, topography, soil, temperature, humidity, type of vegetable cover, etc., found in different situations all modify the influence of the forests on water conservation. Numerous studies show that forests have a very marked effect on water conservation. On the other hand, some studies indicate quite clearly that the effect of the forest is very slight. A large part of our difficulty may be laid to human frailty in generalizing from that source which best suits our convenience. Secondly, most of the studies of runoff have been made at the mouths of rivers that have several tributary streams. This cannot lead to any definite conclusions because of the compensating or opposing effects of the tributaries. *For these reasons the only studies that can give us the facts with reference to run off are those made at the source of the rivers and they will tell us only the effects of forest on these particular streams.* Again, in the determination of the influence of forests on any of the physical factors that have a bearing on water conservation, namely, precipitation, temperature, soil, topography, etc., the effects of all other factors must be eliminated.

Although my topic is forests and water conservation there is such a wide spread interest and so much misinformation concerning the influence of forests on climate that I believe you will not mind if I digress for just a moment to give you a brief summary of the established facts concerning this related topic. Accurate observations, continued for many years in different parts of the world, establish with certainly the following facts in regard to the influence of forests upon climate:

"The forest in the summer lowers the temperature of the air inside and above it. The vertical influence of forests upon temperature extends in some cases to a height of 5,000 feet.

"Forests increase both the abundance and frequency of local precipitation, as compared with that over adjoining unforested areas, amounting in some cases to more than 25 percent.

"The influence of mountains upon precipitations is increased by the presence of forests. The influence of forests upon local precipation is more marked in the mountains than in the plains.

"Forests in broad continental valleys enrich with moisture the prevailing air currents that pass over them, and thus enable large quantities of moisture to penetrate into the interior of the continent. The destruction of such forests, especially if followed by weak, herbaceous vegetation or complete bearing of the ground, affects the climate, not necessarily of the locality where the forests are destroyed, but of the drier regions into which the air currents flow.

"While the influence of mountain forests upon local precipitation is greater than that of forests in level countries, their effect upon the humidity of the region lying in the lee of them is not very great."

Established Facts

The above facts have been definitely established through many years of careful study at the forest experiment stations of Europe. Time will not allow me to analyse these in further detail. If any of you are interested in going into this matter further I cannot do better than refer you to a recent bulletin of the Lake States Forest Experiment Station entitled, "Forests and Waters in the Light of Scientific Investigation." This bulletin gives a very thorough analysis of the subject as expressed in its title.

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PHOTO COURTESY U. S. FOREST SERVICE

The result of timbering followed by a fire caused by the operation.

Coming now to our main topic let us examine first into the question, "What becomes of fallen rain?" It is disposed of in the following ways:

(1) Surface runoff—that is the water which collects into little streams and flows off into the rivers over the surface of the ground.

(2) Seepage runoff—the water sinks into the earth but reappears within the same drainage area.

(3) Deep seepage—water which sinks into the earth but does not reappear within the same drainage basin but may in an adjacent or more distant one.

(4) Fly-off, water which is returned to the atmosphere from objects upon which it has fallen, from the surface of the earth, from bodies of water, and from the soil.

(5) Water of transpiration, that which sinks into the soil but is brought back to the surface through plants and evaporated into the air from their leaves.

(6) Organic water, that which is taken from the soil by plants and animals and built into their tissues.

You can readily conceive that the differences in climate, soil, topography, vegetable cover, etc., of different localities will have a very marked difference in effect upon any or all of these ways in which fallen rains disappear.

Let us look into the more important of these. If it can be shown that mountain forests increase seepage at the expense of surface runoff their influence as an important factor in flood control and the conservation of water must be acknowledged. We are not perhaps so much concerned with the fly-off, the water of transpiration, and the organic water as we are in the seepage and runoff except in so far as the former may have a bearing on the latter. Let us dispose of the secondary influence first.

Losses Through Interception

It is true that forests increase the amount of water lost through interception (water intercepted by the trees and evaporated before it reaches the ground) and that they bring back to the atmosphere enormous quantities of water through transpiration. Evaporation from from the soil is, however, very materially retarded. Most of the observations on evaporation and transpiration have been conducted in the plains. The observations in mountainous regions have been less extensive but tend to show that the water lost through these sources is far less at higher altitudes and on steep slopes.

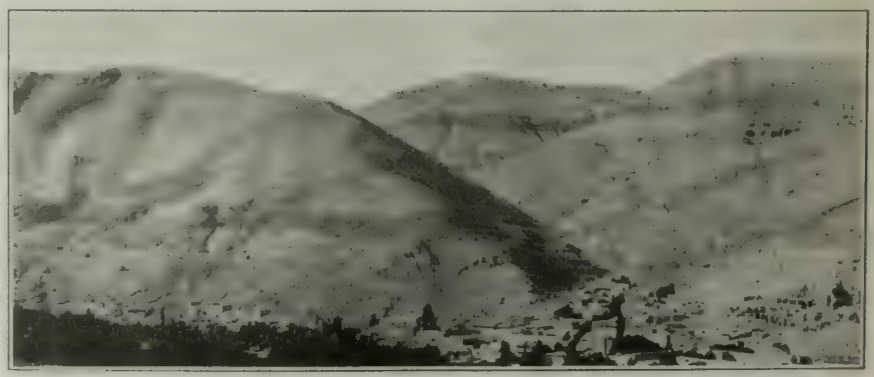
The water returned to the air through interception is quite variable. Under conditions of light rainfall of short duration the forest may intercept all of it so that none reaches the soil but under heavy or prolonged periods of precipitation the precentage returned to the air is negligible. Studies made in Europe show that under normal conditions of rainfall anywhere from 5.85% to 39% of the intercepted water will be returned to the atmosphere.

Concerning evaporation of water from the soil Ebermayer's observations show that during the summer months the ratio of evaporation from forest soil covered with leaf litter is only 15.4% and without leaf litter 39% of the amount evaporated from a similar soil in the open. The effect of the forest on soil evaporation will be readily appreciated when we consider that the factors which favor evaporation, such as temperature, velocity of wind, humidity of the atmosphere, etc., are all of them less favorable under forest conditions.

Losses Through Transpiration

Transpiration is a complicated physiological process and seems to vary with species, temperature, amount of soil water available, and a number of other factors. Hohnel estimates from extended studies that a fully stocked beech forest 115 years old will consume from 1560 to 2140 tons of water per acre per year. The latter figure is equivalent to 1.15 acre-feet and represents 25% of the annual precipitation. Coniferous forests of fir and pine, however, used only about ⅛ as much water per pound of dry leaf substance as beech. Ney determined that with a rainfall of 31.5 inches an average of 23.2% of the total precipitation is returned to the air through transpiration.

While these appear like tremendous quantities of water for the trees to evaporate from their leaves, and which would be lost to the streams, the total loss through evaporation, transpiration, and



COURTESY AMERICAN GREEN CROSS

Deforestation. These bleak hills were once covered by a heavy forest. Now they are snow covered in winter, sun-baked in summer, the battle ground of the elements.

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organic water, is only very slightly greater in forests than from field crops, and some field crops use more water than certain tree species. Since in all these cases the relative humidity is increased and the temperature of the forest air lowered they favor condensation resulting in fog, dew, and hoar frost, so that not all of it is lost. Here, again, we must not forget that the examples given pertain only to the particular locality in which the studies were made and cannot be used to generalize. In the last analysis, however, the important influence of the forest in water conservation is its influence in increasing seepage at the expense of runoff. Let us examine the factors that influence seepage.

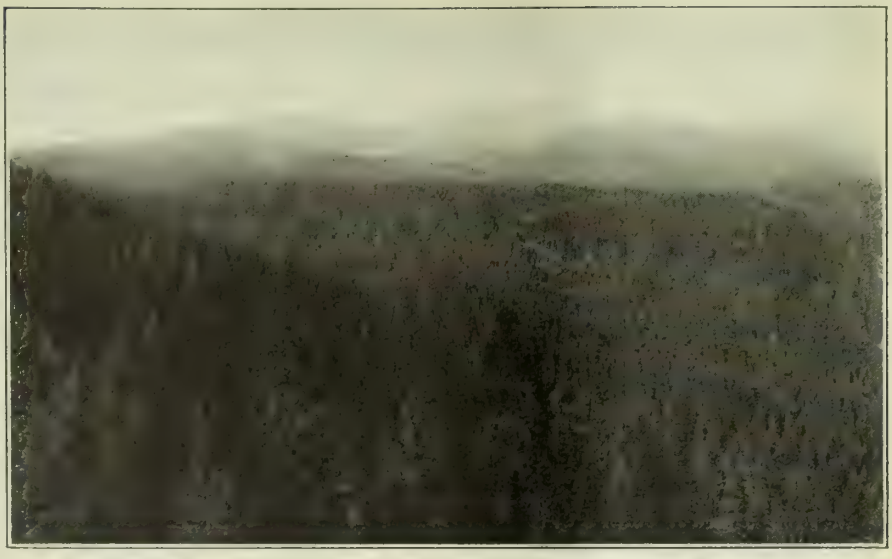


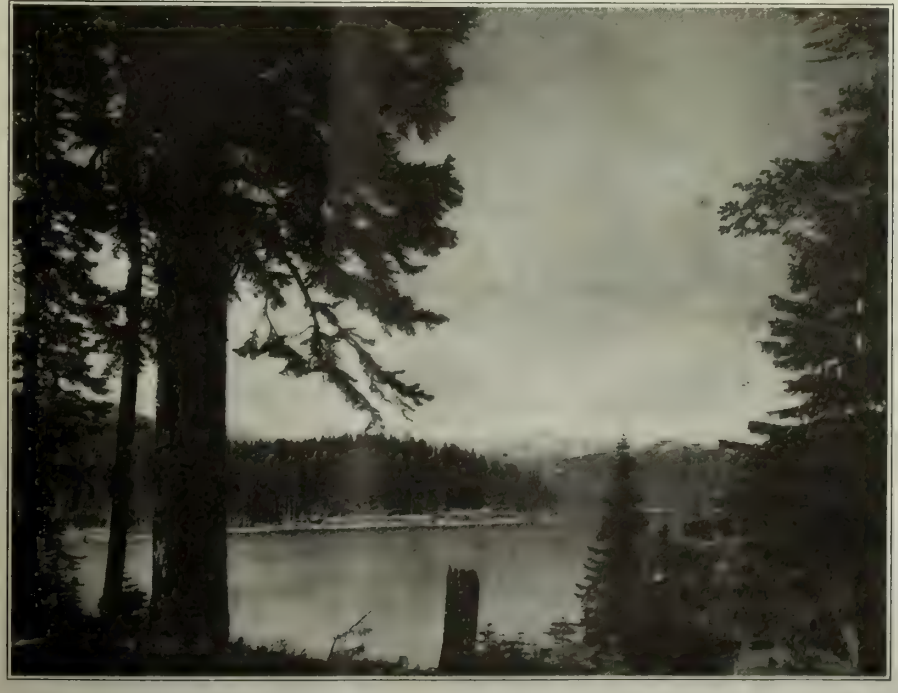
PHOTO COURTESY U. S. FOREST SERVICE

A stand of timber on the Columbia National Forest, Washington.

Factors Influencing Seepage

First, the amount and character of the precipitation. If water reaches the soil in small quantities at frequent or prolonged intervals far more will enter it as seepage than when the same amount reaches the soil during a comparatively short period. A heavy rainfall for a short time on a forested slope will reach the soil much more slowly than on one which is not forested. The forest breaks the force of the fall and the water slowly trickles down to the dead leaves, twigs, and humus below. It reaches the soil much more slowly than it does on the deforested slope. However, with a light rainfall all of the water may be intercepted and with a heavy rainfall this particular influence is only momentary. Under average normal conditions, however, this influence of the forest is of very considerable importance.

Second, the character of the soil, subsoil and underlying rock. It is hardly necessary to call your attention to the capacity which different soils have for taking up and holding water. Sand, gravel, and broken rock allow the water to pass through in great quantities about as fast as it comes to it. Clay, on the other hand, takes up water very slowly but holds it a long time. Humus, and soil mixed with considerable humus, take up water about as fast as a sponge and can hold great quantities of it. Measurements made in Europe show that on 2½ acres of spruce and beech forests the humus had a retentive capacity of 46.44 and 22.20 tons of water per acre respectively. In volume this amounts to 1510 cubic feet per acre for spruce and 712 cubic feet per acre for beech humus, equivalent to a rainfall of 0.41 inches and 0.20 inches respectively. The depth of the soil too is an important consideration. It is quite evident that a deep soil can take up and hold more water than a shallow one. In addition to adding soil to the surface from the leaf litter of the trees the roots of the trees tend to break up the subsoil and underlying rocks. Of course, when the surface layers once become saturated any additional water would run off nearly as fast as it would over the bare ground were it not for the obstruction offered by the litter on the forest floor. (Further reference to this will be made later.)



COURTESY AMERICAN GREEN CROSS

A forested area, showing snow covered hills in the background and natural storage reservoir in the foreground. This is a typical scene in any Western forest reserve.

Third, character of topography. It is quite obvious that the steeper the slope and the more extensive the development of a system of surface drainage laterals the more rapidly will the water flow off. The forest is recognized as a most effective of all vegetable soil covers in the prevention of erosion and hinders the development of what soon becomes a most efficient surface drainage system on slopes not forest covered. The main gullies with their laterals extending to every part of the denuded slope make a most effective system for the rapid removal of the water through surface runoff.

Vegetable Cover

Fourth, the character of the vegetable cover. The forest is not only important because of the points already mentioned

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Details of Design, Construction and Various Costs of the McKay Dam

Actual Cost of Structure Considerably Below Engineers' Estimate—Saving Made in Construction by Proper Use of Modern Machinery

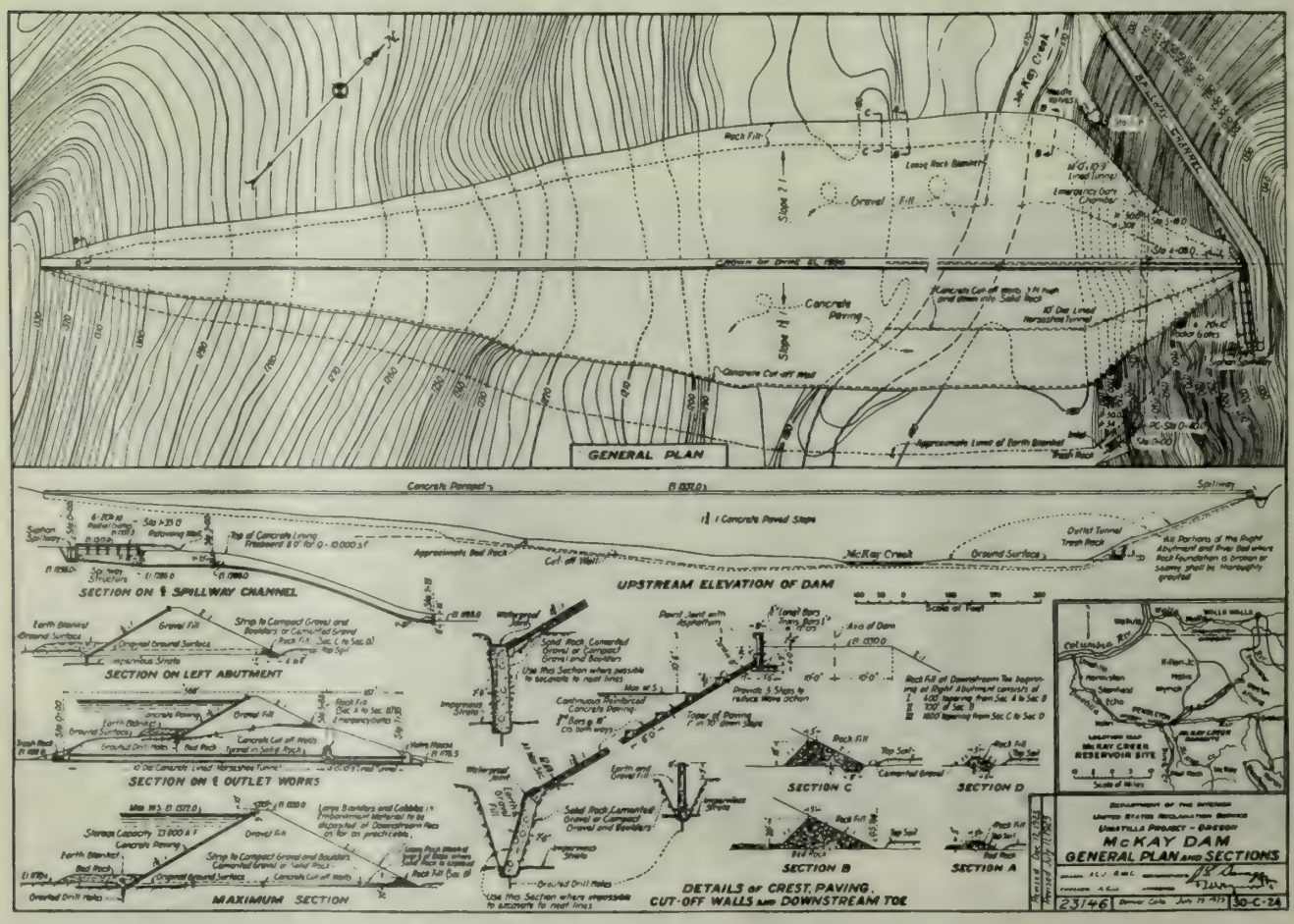
By BYRUM W. STEEL
Engineer—Denver Office U. S. B. R.

McKAY DAM, which is located on McKay Creek 5 miles above its confluence with the Umatilla River and 7 miles south of the town of Pendleton, Oreg., has recently been completed. The dam and all appurtenant works were constructed entirely by Government forces. The storage capacity of the reservoir created by this dam is 73,000 acre-feet of water, which will be used to supplement the natural flow of the Umatilla River for the irrigation of approximately 35,000 acres, now partially developed, in the Stanfield and Westland irrigation districts and in addition will furnish water for other lands being investigated. The reservoir is a mile wide and 4 miles long and receives its storage water from both McKay and Birch Creeks, the flood waters from Birch Creek being diverted to the McKay Creek watershed through a feeder canal. The completed Umatilla project will comprise the original project of 17,000 acres, the west extension of 11,000 acres, and the 35,000 acres mentioned above, making a total of approximately 65,000 acres.

Description of the Dam

The dam is a gravel embankment of 2,287,010 cubic yards having a crest length of 2,700 feet and a maximum height of 165 feet. The downstream slope is 2 to 1 and the upstream slope 1¾ to 1. Before starting the embankment it was necessary to strip the left abutment and the creek bottom of all top soil down to the compact gravel or solid rock. The quantity of stripping was 160,000 cubic yards and was started in July, 1923. The stripping was done with Fresnos where the haul was less than 300 feet and the remaining area was handled by loading into dump wagons with an Austin dragline equipped with a one-half yard bucket and hauling with teams. The earth blanket shown in the maximum section is composed of the top soil stripped from the foundation, which was deposited along the upstream toe of the dam and later spread as indicated on the drawing.

The material in the embankment consists of a well-graded gravel with a variable content of sand and earth as a binder. This material was obtained from the creek bottom above the dam with an average haul of about 1½ miles. The borrow pits were irrigated sufficiently to



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give the embankment material the right amount of moisture to insure the maximum degree of consolidation when rolled. All material was excavated with two 80-B electrically operated Bucyrus shovels, loaded into 4-yard dump cars remodeled to hold 6 yards and hauled to the dam an average distance of 1½ miles with 18 and 20 ton oil-burning dinky locomotives. After the gravel was dumped from the cars, it was spread in layers not to exceed 8 inches in thickness with horse-drawn grading machines and compacted by rolling with traction. Each 8-inch layer of the fill received four trips of the roller, except a strip about 15 feet wide along the upstream slope of the embankment which received six passes of the roller. The embankment was built to an upstream slope 2 feet outside the theoretical slope and the excess material excavated and placed in the embankment.

The gravel fill was started in February, 1924, and was finished in December, 1925, continuous operation being maintained except for about one month during the winter of 1924-25. The total embankment contains 2,287,010 cubic yards and was placed at the average rate of 110,000 yards per month. The maximum daily run was 8,000 yards in two shifts and the maximum yardage placed in any one month was 165,000, which was placed April, 1925.

Equipment

The equipment used in building the gravel embankment consisted of two 80-B electrically operated Bueyrus shovels used in the gravel pit, 5 traction engines and 3 grading machines used on the fill, 11 oil-burning dinky locomotives and 120 six-yard dump cars used in hauling the material 1½ miles from the borrow pit to the dam.

The upstream face of the dam, the slope of which is 1¾ to 1, is protected by a continuous reinforced concrete slab varying in thickness from a minimum of 8 inches at the top to a maximum of 12½ inches at the bottom of the highest section, the rate of increase of thickness in the concrete face being 1 inch in 70 feet down the slope. The reinforcing consists of ¾-inch round bars placed at 18-inch centers both ways and approximately in the center of the slab. The concrete was poured in alternate strips 12 feet wide placed up and down the slope at right angles to the longitudinal axis of the dam.

This reinforced concrete face slab connects at the crest of the dam with a cantilever type parapet wall 6 feet 6 inches high, being 2 feet 6 inches above the crest. At the intersection of the 1¾ to 1 slope with the cemented gravel or rock surface the face slab terminates in a cut-off trench to solid rock. In this cut-off trench in the lava rock foundation grout holes were drilled with a model 21 turbro drill mounted on a derrick at from 3 to 10 feet centers and varying in depth up to a maximum of 45 feet. After this cut-off trench was filled with concrete, cement grout was forced into the holes under air pressure of approximately 100 pounds per square inch. The yardage of concrete in the cut-off trench is 1, 656, in the concrete face 17,251, and the linear feet of grout holes drilled in the bottom of the cut-off trench 11,201.

Detail cost of McKay Dam

Item		Quantity	Unit cost	Total cost
Examination and surveys				$17,248.02
Clearing and care and diversion of river				9,966.20
Excavation:				
Class I, dam	cubic yards	2,266	$0.35	790.18
Class I, stripping for embankment	do	160,155	.36	57,669.77
Class I, dam	do	2,955	.62	1,867.85
Do	do	1,758	.93	1,634.15
Class II, dam	do	1,098	2.41	2,650.89
Class III, dam	do	2,099	8.26	17,346.80
Class I, spillway	do	1,601	1.05	1,687.72
Class II, spillway	do	341	.67	227.79
Class III, spillway	do	2,553	2.09	5,344.46
Class III, spillway channel	do	32,234	2.24	72,332.90
Class I, outlet	do	266	1.40	372.35
Class II				346.88
Class III, open cut	cubic yards	1,411	3.31	4,682.30
Class III	do	360	3.97	1,430.59
Class III, tunnel	do	4,186	6.42	26,886.05
Embankment		2,287,010	.44	1,008,544.03
Structure drainage (dam)				71.17
Do	cubic yards	5,635	1.94	10,958.19
Do	do	45,563	.417	19,032.54
Structure drainage (spillway)				2,052.55
Grouting (outlet works)				2,698.67
Grouting (upstream cut-off in dam)	linear feet	11,201	1.43	16,034.92
Concrete:				
Dam, reinforced in cut off trench	cubic yards	1,656.5	12.55	20,787.78
Dam, paving	do	17,251.4	14.90	256,735.04
Dam, reinforced	do	875.4	18.15	15,889.79
Do	do	594.8	19.54	10,744.54
Spillway, reinforced	do	385	12.50	4,693.89
Do	do	1,902.5	16.45	31,301.07
Do	do	580.4	24.38	14,154.62
Outlet, reinforced	do	165	17.57	2,899.87
Outlet, tunnel lining	do	1,757	16.85	29,603.75
Outlet, reinforced	do	48	24.60	1,181.75
Do				10,439.88
Riprap	cubic yards	432	5.48	2,385.60
Backfill				5,324.49
Six 20 foot by 10 foot radial gates	pounds	88,665	.20	17,526.99
Two 4 foot by 4 foot high-pressure emergency gates	do	95,920	.19	18,779.90
Two 48-inch balanced needle valves	do	44,055	.26	11,606.57
54-inch riveted steel outlet pipe	do	89,375	.12	10,860.66
Gates				730.58
Structural steel				1,377.58
Hand railing				469.99
Lighting system				2,941.38
Electric installation				2,365.11
Right of way and lands				176,133.25
Permanent improvements (gate tender's cottage)				3,097.19
Camp maintenance				34,449.20
Engineering inspection				49,955.27
Total estimated field cost				2,018,312.71
Superintendence and accounts				43,353.41
General expense				55,161.98
Grand total actual cost				2,116,828.10
Estimated cost				2,500,000.00

Outlet Works

The release of water from the reservoir for irrigation purposes is effected by means of a tunnel and two 48-inch balanced needle valves. The tunnel is located in the right abutment and was used to divert the stream flow during the construction of the fill. The total length of the tunnel, which is concrete lined throughout, is 705 feet, the upper 550 feet being a 10-foot horseshoe section. At the upper end of the tunnel is a reinforced concrete trash rack. The trash bars are five-eighths inch by 6 inches in section placed 6 inches center to center. The upper 550 feet of tunnel operates under pressure at all times. At the lower end of this section are mounted two 4 feet by 4 feet high-pressure emergency gates. From each of these a riveted steel pipe 54 inches in diameter delivers the water through the remaining 155 feet of tunnel to the 48-inch balanced needle valves at the downstream toe of the dam. These needle valves and the control mechanism are housed in a reinforced concrete house connecting with the lower end of the tunnel. Access to the emergency gates in the tunnel is through the needle-valve house.

The tunnel, which is in hard blue basalt and the softer forms of lava, was driven from both portals. No timbering was required and the excavation was completed in approximately three months. The tunnel muck was placed in the drain trench at the downstream toe of the dam.

Spillway

The spillway is of the side-channel type, concrete lined, and is located in the

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Status of Ownership of Return Flow Waters Puzzle to the State Water Masters

Legal Aspects of Private Versus Public Ownership of Return Flow Waters Still Obscured by Lack of Decisions

By R. I. MEEKER

Consulting Irrigation Engineer, Denver, Colorado

A CURSORY survey of recent activities in the western United States discloses a desire and tendency on the part of a few water users toward private control and sale of return flow waters from irrigation and other uses. The underlying motive is economic and has its origin in increased values of water and contemplated revenue which may be used to reduce project costs or project maintenance.

The above statement is impelled by specific instances of recent contracts of sale of return flow water, or attempts to secure ownership of return flow, and efforts to traffic in same in seven states, viz., Arizona, California, Colorado, Idaho, Nebraska, Oregon and Texas. This article is also inspired by recent articles on return flow, several of which advocate private control and disposal of such water, especially those from irrigation use. A bibliography is attached covering such printed articles.

Return Water Portion of River Supply

When one realizes that consumptive uses of water for municipal and industrial diversion approximate but 10 to 15 percent of headgate diversion, and that consumptive uses for irrigation purposes are generally less than 50 percent of headgate diversions, it becomes apparent that the residue waters are a large part of river supplies, and efforts to secure private control of such water are a serious menace to constitutional provisions of state laws on ownership and control of public water supplies; are in direct opposition to the legal fabric in the irrigation world built up by legislative acts and court decisions of most of our western states; and are against the best interests of water users as a whole.

Agencies endeavoring to secure ownership of return flow waters, means employed and character of return flow may be tabulated for ready reference as shown on opposite page.

If such attempts and efforts to secure ownership and control of return flow waters were to be finally successful, and were they to become general by legislative sanction, by court approval, by state grant, by stipulation, or by indifference of water users, then irrigation history will be replete with efforts to throw off a burden which will in both junior and senior down-river water users paying tribute to up-river development, and a dangerous parasite will be grafted upon the public ownership and control of state waters. Such a proposition is unthinkable and contrary to basic principles of water law.

RALPH I. MEEKER

Consulting Civil and Irrigation Engineer of Denver, Colorado. Mr. Meeker's experience as engineer for Colorado on Interstate River Problems, and his wide investigational work with various governmental projects places him in the position of an authority on legal irrigation problems.

No Valid Objection

No valid objection is raised, or can be raised, to re-use of waters within a project because such use is fundamentally sound and automatically results in decreased headgate diversions for the project, thereby releasing direct flow for future up-stream or down-stream development. Such re-capture and re-use are provided for by legislative act in some of the laws of the western states, and in others are sanctioned by court decisions. Nebraska irrigation law specifically provides that supplemental water rights may be acquired by canals and ditches from return flow or other waters, provided the headgate diversion on the main river supply is correspondingly reduced.

If one irrigation project on a river system is entitled to sell and dispose of its return flow waters, then, in theory at least, every other project or ditch should be entitled to tribute for return flow waters from irrigation uses. Were such a theory of control and ownership of return flow carried to its logical conclusion, there would be little or no public water in the lower sections of some of our western streams. Furthermore, at this late date to attempt to plaster such a preferential right upon our legal fabric would be unsound, discriminatory, and result in chaos in stream administration. If certain projects or canals are foolish enough to stipulate away their rights to return flow, to which they are entitled under existing law, that is no reason for widespread citation of such an act as an argument in favor of private ownership of return flow for the remaining water users in a stream system or for other stream systems.

That private ownership of return flow should not obtain is evidenced by the basic legal principle that a *water user does not acquire a property right to water*, but only the right to the use of water; in legal verbiage, a "usufructuary right." Quoting from Kinney on Irrigation, pp 548, 549:

"There can be no absolute title to the corpus of the water of a stream, or other body of water, either by the public, state or individual, so long as it is flowing naturally. As we have seen, there may be an absolute title to the bed and banks of water course or other body of water, but the water itself is never stationary; and, so long as it remains in its natural course it cannot be brought into the possession of anyone, and hence it follows that there can be no absolute title to it. It is like the air—a naturally flowing substance, incapable of absolute ownership. Justinian says that the things common to mankind by the law of nature are the air, running water, the sea, and consequently the shores of the sea. However, a

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SUMMARY OF EFFORTS TO SECURE PRIVATE OWNERSHIP AND CONTROL OF RETURN FLOW WATER

AGENCY	MEANS USED	CHARACTER OF REURN FLOW
A large municipality in Colorado.	Attempts to secure legislative sanction.	Increased sewage return from municipal uses and prospective return flow from projected irrigation uses of trans-mountain water from the Colorado River.
Drainage Districts in Colorado	Efforts to make contractual sales or to secure legislative sanction.	Drainage recovery from irrigation uses.
Individuals and corporations in California.	Efforts to make contracts or file applications and secure permits for use of return flow from power projects to detriment of prior appropriators.	Water used for generation of hydroelectric power after release from storage and use through power wheels.
A large irrigation project in Wyoming and Nebraska.	Actual contractual sales of reservoir water to non-project ditches with stipulation to substitute project and drainage recovery in lieu of reservoir water.	Return flow and drainage recovery from irrigation uses which revert to river and would automatically supply lower ditches with prior rights.
A large Irrigation project in Idaho.	By alleged stipulation in water decree when water right was adjudicated in State Courts whereby return flow of upper project is delivered in lieu of reservoir water to lower project.	Return flow and drainage recovery from irrigation uses which revert to river and automatically would supply lower project according to priority.
A large Irrigation project in New Mexico and Texas.	Actual yearly contractual sales of seepage, drainage recovery and waste waters to lower project.	Return flow, drainage recovery and waste of project which revert to river, and would automatically supply junior project below.
Proposed projects or extensions of federal projects in Oregon and other western states.	By contractual stipulation with valley water users who are practically asked to quitclaim any rights to prospective return flow from project to be constructed.	Return flow and drainage recovery from project which would automatically go to prior users below.

right may be acquired to the use of running water, or to a certain amount of running water, which the law will regard and protect as property. Further than this the law will not, because it cannot, go. As well might the law attempt to apportion a certain amount of the air to one state, or to one individual, as to attempt to apportion a certain amount of running water. Water, in its natural condition, is constantly moving. It flows by or through one man's property today, and by tomorrow it is in another. Yet we often hear to see the expression of ownership in running water; this is especially true in the court decisions. There may be a right to use the water, but there can be no absolute ownership of its corpus. Neither sovereign nor subject can have any greater than a usufructuary right in running water."

In this connection see the recent decision of the Montana Supreme Court in the case of *Tucker vs. Missoula Light and Water Co.*, 250 Pac. Rep., 11 (October 4, 1926). Similar Supreme Court decisions in other states could be cited.

Return Waters are Public Property

The principle is so well established and recognized in the water world, and affirmed by court decisions, that attempts to acquire private ownership and control of return flow must be classed as revolutionary. Under the above mentioned principle, under legislative act and by court decision, return flows, whether from municipal, industrial, power, or irrigation uses, automatically revert to the public water supplies.

The State of Colorado, early in its irrigation history, recognized the importance of return flow in water supply of river systems by enactment of the following law in 1889:

"Section 1. That all ditches now constructed or hereafter to be constructed for the purpose of utilizing the waste, seepage or spring waters of the State, shall be governed by the same laws relating to priority of right as those ditches constructed for the purpose of utilizing the water of running streams; *Provided,* That the person upon whose lands the seepage or spring waters first arise, shall have the prior right to such water if capable of being used upon his lands."

Colorado court decisions declare that seepage waters become public water on entering natural streams.

The new theory being advanced of private control and ownership of return flow waters, is quite specious and is readily seized upon by prospective beneficiaries without realizing that it is fundamentally opposed to irrigation law, a long line of court decisions, and public ownership of river supplies. The term "compensating system of credits for developed water," stripped of its illusory verbiage and reduced to terms of the lowest common denominator, simply means private control and sale of return flow to water users who, by priority of position or right, or both, are entitled to such return flow as a part of the public water supply. In Colorado a long line of court decisions sustain public ownership of return flow.

Few Legal Decisions in Some States

In some states it is true that there are relatively few court decisions on disposition and ownership of return flow. Such as have been made unquestionably sustain the use of return flow within a project or on lands for which the original appropriation is made,—beyond this they do not go. The writer is familiar with the Ramshorn case in western Nebraska, and the Bitter Creek case on the Shoshone Project in Wyoming, return flow litigation cases, and sometimes cited by advocates of private control of return flow.

Exponents of the theory of private ownership and sale of return flow can find but little comfort in present court decisions concerning ownership of return flow, although it is readily conceded that incorrect statements are made and conclusions drawn from present court decisions to sustain the position taken. Furthermore, as previously indicated, such advocates are making efforts to secure decisions favorable or in harmony with their desires of private ownership of return flow waters, and unless state irrigation officials and water users scrutinize with care such litigation and oppose vigorously such court efforts, the west will wake up some day to see a thread in the legal fabric which is inimical to public ownership and control of waters.

Controversy of Some States

This contest for private ownership, control and sale of return flow waters is already taking a dominant position on the irrigation stage in Nebraska where public vs. private ownership of return flow waters of the North Platte River is actively in progress and has been in contention for several years. On the Snake River in Idaho the same controversy is underway over return flow and drainage recovery of a large project. In Texas on the Rio Grande in El Paso Valley the trend along these lines is unmistakable. In Arizona outright sales of pumped drainage water have been made in the Salt River Valley. In California state irrigation officials are confronted with a problem over control and ownership of reservoir water after use through power wheels for generation of hydroelectric energy. In Oregon a federal

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The EDITORIAL

HYDRAULIC Engineering
With which is included
MODERN IRRIGATION—WESTERN WATERWORKS

Reg. U. S. Pat. Off.

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Success of Irrigation

THE importance of irrigation in the western United States is evidenced by many reports and statistics emanating from the various statistical departments of bond and investment company offices. It is interesting to note, in one of these recent reports, that there are at the present time, in California alone, over $100,000,000 in irrigation bonds outstanding, the lands securing these bonds having a total present valuation in excess of $800,000,000. It is also pointed out that before these lands were provided with irrigation facilities, they did not produce crops in sufficient quantities to justify a valuation of more than $25,000,000, which is but one thirty-second of the present valuation.

Irrigation is directly responsible for the phenomenal growth of certain sections of the west, and in California, as was pointed out above, was alone responsible for the net increase in land values of $775,000,000. To the uninitiated, this increase may seem quite out of proportion to the earning capacity of the lands, but this is not the case, as these same lands, according to the reports, show an average annual gross return (taken over a five-year period) in excess of $200,000,000.

California has approximately 6,000,000 acres under irrigation, of which 4,000,000 are in irrigation districts. It is interesting to note the successful operation of these districts, evidenced by the fact that no new major agricultural development of water conservation of any character has been attempted during the past fifteen years except under the district form of organization.

California Water Laws

THE recent decision of the Arizona court regarding the adjudication of the water rights on the Agua Fria River, is of prime importance to that state, as it sets a precedent in the legal records. Other irrigation states in the west have had this problem settled before, some of them many times. California, for instance, owing to its early mining history, has probably experienced more litigation involving irrigation law and procedure, than any other state. This state has always had a small water supply, and ever since its development there has been a large demand for this limited supply. In the early days of California, the adventurous miner took water from the streams, utilized it for the washing of gravels, and hydraulicing the banks of distant hills. The procedure often diverted the water from its natural stream bed, at the expense of users further on down the river. In the course of time, laws were formulated and decisions rendered by the various courts, so that at the present time, there have been established certain rules of practice which pretty well cover the entire field of water appropriation.

Neighboring irrigation states are ready to follow the leadership established by California, and it is natural for the legal fraternity to look to California for a precedent, when there is a question of irrigation or water rights involved.

This leadership has been obtained, to a large extent, by the unique state organization within the Division of Water Rights, which is constantly aiding the legal side of hydraulics.

A situation in California similar to the Arizona case was recently settled by compromise. The trouble arose over the erection of a 70-foot dam at Railroad Canyon, near Lake Elsinore, (Southern California) by the Temescal Water Company of Corona, to impound waters owned by this company for irrigation purposes. The case was settled out of court, the Temescal Water Company agreeing to allow one-sixth of all waters to flow into the gravel cone below the dam, where it will be stored underground to replenish the supply for wells. The Temescal Water Company is to pay the Elsinore Water Users' Association $23,000 to be used in defraying expenses of litigation already incurred. It is very probable that if the case had been carried on into the higher courts of the state the Corona Company would have lost, the expenses of litigation consequently would have been much greater, and the amount of water allowed the Corona Company would have been less than that received in compromise.

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POINT *Of* VIEW

Cost of Irrigation Water

IN the early history of irrigation the charges for operation and maintenance of irrigation works were based either on a flat rate per acre or on a unit flow of water such as the miner's inch or the second foot. As the evil effects of excessive use of water became more prevalent the question arose as to whether these units were the proper ones on which to base charges. It had long been known that cities had found that the flat rate for water service was uneconomical and unsatisfactory as compared with the quantity rate. It was recalled that all other commodities were paid for on a quantity basis. Why should not irrigation water, also a valuable commodity, be paid for in the same manner? This reasoning was sound; and, in the last twenty years there has been a growing application in the quantitative method of making operation and maintenance charges.

So strong had the sentiment become that in 1914, when Congress passed the "Reclamation Extension Act," they provided for the payment in advance of operation and maintenance charges, and such charges should be made on the basis of the acre-foot of water as a unit for all projects under government control. This plan has worked out very satisfactorily ever since its adoption.

There is, however, one serious obstacle to the quantity basis for making operation and maintenance charges, and that is the difference in the duty of water for different soils. It is a well known fact that as soil varies through its different types from clay down to sand, the duty of water decreases; and, since an irrigation project is quite likely to have two or three or even more distinct types of soils, different water users will necessarily need different quantities of water to produce the same crop results. It then becomes necessary either to apply one duty of water to all of the land or fix a different duty of water for each class. Neither of these procedures is exactly desirable, though one or the other may be applied with a fair degree of success. In any event, it is believed that the advantages of the quantity basis for making operation and maintenance charges outweigh its disadvantages.

A Boomerang

THE decision of the Arizona court relative to the water rights of the Southwest Cotton Company along the Agua Fria River, may in time prove to be a decided detriment rather than a benefit to the victors. The general outline of this decision is given in this issue of Hydraulic Engineering, and the map accompanying shows the situation of the lands of the Southwest Cotton Company relative to the lands of the Beardsley Land and Investment Company. It is the opinion of several engineers, who are thoroughly acquainted with the situation, that there will probably be another law suit within the next few years instituted by the Southwest Cotton Company to enjoin the Beardsley Company from increasing the level of the underground reservoir that is known to exist.

By glancing at the map shown on page twenty-three, it can be seen that the lands of the Southwest Cotton Company lie to the east of the lands of the Beardsley Company, and that the natural slope of this land is gradual from the White Tanks Mountains eastward to the Agua Fria River. It is highly probable that the underground strata slope in a similar manner. The slope of the land is quite gradual, averaging from 30 feet to the mile at the base of the mountains on the north and west, to fifteen feet to the mile as the river flattens out upon the broad plane to the south.

It is the plan of the Beardsley Land and Investment Company to irrigate some forty thousand acres shown on the map as the lands of the Maricopa County Water Conservation District No. 1. These lands are higher in elevation than the lands of the Southwest Cotton Company, and as previously stated, the natural drainage is to the east. It is natural to assume, then, that the underground drainage will be eastward to the Agua Fria River, thence southward to the Gila. As the Agua Fria River travels southward toward the Gila, the natural slope of the land decreases, and the natural drainage will be slower in action. This means that the underground reservoir will probably be raised, and may cause water-logging of the lands along the lower portions, similar to conditions that are prevalent in certain sections of the Salt River Valley. The lands which lie along the natural course of the Agua Fria River are in most portion the property of the Southwest Cotton Company, and should such a condition arise, as it probably will, there will undoubtedly be another suit instituted to attempt to prevent the water-logging of these lands.

The Art of Irrigation

THE art of irrigation dates back to the beginning of written history. A great succession of civilizations, notable and extensive, have flournished on irrigated soils. Irrigation, therefore, is no modern discovery. All that we have learned to do in this modern day and age is to place our modern civilization safely under the irrigation ditch. The irrigation practises of ancient peoples were necessarily primitive. Their engineering structures were often excellent, considering the time of their building; the laws and regulations regarding the distribution and use of water, were also satisfactory as based upon long experience; though the record of these achievements, especially as to the use of water, has come down to us in an imperfect manner. The use of water on irrigated lands, was not based, in the ancient days, upon scientific principles, but rested merely upon regulations, some of which were wholly contrary to the best of modern knowledge.

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Uneven Flow from Guernsey Reservoir Equalized by Surge Tank of Novel Design

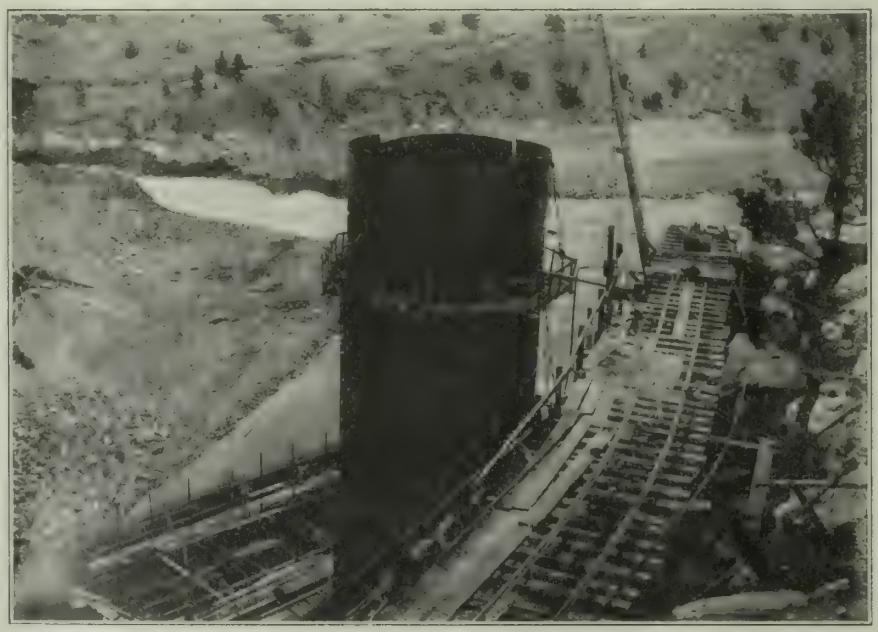
Power Development from the North Platte River Project Becomes Possible After Installing Equalizing Element

By R. E. GLOVER

Associate Engineer, U. S. B. R. Denver Office

THE Guernsey surge tank is one of the vital elements of the Guernsey power plant, the first unit of which has recently been placed in operation. This plant develops power from water released from the Guernsey reservoir, and together with the Lingle plant supplies power for industrial, municipal, and project uses in the territory along the North Platte River in eastern Wyoming and western Nebraska.

The location of the plant at the outlet of a reservoir whose primary purpose is for the storage of irrigation water, makes it necessary to operate under widely varying heads. The use of power by various flour mills and for domestic lighting makes it necessary to hold the frequency and voltage fluctuations within narrow limits. Power is supplied for industrial uses to motor units as large as 800 horsepower, whose intermittent use causes heavy load fluctuations. Water-power plants are inherently difficult to regulate, so that the exacting requirements in this case gave rise to a problem in turbine regulation of unusual interest.



Guernsey surge tank during construction. A floating platform around inside of tank provided working space for the mechanics. (Courtesy Reclamation Era.)

Plant Description

The Guernsey plant is supplied with water through approximately 170 feet of 25-foot horseshoe tunnel connecting with 700 feet of 12-foot circular tunnel. About 5,200 tons of water are inclosed within this conduit, and this great mass must be accelerated or checked each time the load on the turbines increases or falls off. The turbine gates are controlled by a sensitive mechanism which opens the gates if the speed of the turbine drops, or closes the gates if the speed rises above a predetermined value. If the turbines were connected directly to the power tunnel and an increase of load caused the speed of the units to drop, the governor would react by opening the gates. Under this condition the head required to accelerate the water in the tunnel to its new velocity would be taken from the effective head on the turbine, and the first result of a demand for extra power is an actual falling off of the output of the turbine.

On a decrease of load the converse is true, in that the closing of the turbine gates causes the pressure to rise, and the first result is an increase in the power output of the turbine. To gain an idea of the magnitude of the transient power deficiency for this plant, a computation was made on the basis of an instantaneous load addition of 1,360 horsepower, or 20 per cent of the full load capacity of the completed plant. The calculation showed that the power supply would be deficient for nearly eight seconds with an accumulated deficiency of 27,000,000 foot-pounds of energy. This is a somewhat greater load change than is expected but the computation shows that a flywheel some sixty times as large as could be obtained would be necessary to provide satisfactory service.

The need for shortening the distance from the turbines to a free-water surface, as well as the necessity for limiting the pressure rise following a release of load to what could be safely borne by the power tunnel, made the installation of a surge tank imperative.

As finally designed, the surge chamber is a steel tank 85 feet high with a uniform inside diameter of 22 feet and rests directly on the concrete anchor at the junction of the power tunnel and penstocks. This arrangement is mutually beneficial since the anchor not only supports the surge tank but the surge tank and the water it contains provides a large proportion of the weight necessary to insure the security of the anchor. The uniform diameter from top to bottom is necessary both to provide the required area through the total range of head and to shorten the effective penstock length as much as possible. The resulting appearance is somewhat unusual and is said to have caused one engineer to remark that "the Guernsey plant is the only water power plant in the world with a smokestack."

Tank Proportions

The proportioning of such a tank so that it will properly perform all its functions and at the same time be as economical of material as possible is no small

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Important Irrigation Problems Discussed by 17th Annual Oregon Reclamation Congress

Cooperation Was Watchword of Meeting—Many Committees Appointed to Report upon Various Projects Now Contemplated

By D. C. GLINES

NEARLY one hundred men with practical experience in irrigation matters registered at the seventeenth Annual Oregon Reclamation Congress, according to W. L. Powers, Secretary of the Congress who has just returned from the annual meeting at Prineville, October 13 to 15. Two busy days were spent including evening sessions the first night and the annual dinner which closed the session the second evening.

Serious, earnest attention was given to the program of re-vitalizing Oregon's distressed irrigation districts and the spirit of cooperation and harmony which prevailed permitted real progress to be made so that there is much room for encouragement. Several resolutions were adopted expressing the sentiment of the Congress on Oregon's reclamation problems. The outlook for a good water supply for next year is very promising.

One of these urged support for the Oregon Reclamation Commission and declared it the public duty of citizens to give their services when requested by the Reclamation Commission, asked for promptness in cooperation of settlers and bond holders; requested the Land Settlement Board to use its good offices to complete the colonization of projects whenever feasible, and where an adjustment has been agreed upon given assurance of success for the farmers upon the land and those to come.

The resolution recites that efforts are being made by the commission and its secretary toward first: organization of bond holders and settlers for the purpose of reaching a fair settlement and formation of committees to act on their behalf in all matters with the Reclamation Commission. Second: survey of the physical properties of each project in order to ascertain the irrigable area and the reasonable value involved. Third: examination of outstanding obligations. Fourth: the refinancing of projects determined to be feasible upon longer terms of credit with a salvaging of the state's investment on a parity with bond holders.

A second resolution endorsed the farm demonstration work on reclamation projects.

A third resolution favors legislation to provide that issuance of warrants against irrigation districts in excess of one dollar and not exceeding two dollars per irrigable area be prohibited except upon the approval of the State Reclamation Commission.

The fourth resolution instructs the Legislative Commission of Oregon Reclamation Congress to prepare and submit to the next legislature, necessary and proper amendments to the existing law so as to provide for the foreclosure of liens for irrigation and drainage districts levies and assessments, separate from that provided for the foreclosure of liens for other taxes and assessments, and that the foreclosure of irrigation and drainage levies and assessments within the time provided by law be made compulsory upon the boards of directors of such irrigation and drainage districts.

Utilization of Stored Water

Another resolution urges an allotment of $230,000 by the United States Reclamation Bureau for putting into shape a distribution system so as to utilize the water stored in McKay Dam, construction of which has cost $2,500,000.

Because Oregon has received less from the Reclamation fund than contributed from the sale of public lands in the past, and since there are other developments in Oregon to be built or completed, which are necessary to the building of this commonwealth—the Reclamation Congress pledged its unqualified support to the program being forwarded and projects supported by Oregon delegation; and pledged to Senator McNary and Congressman Sinnot its cooperation in securing for Oregon complete recognition from the federal government, and voiced gratitude for results already obtained.

It appears that $14,000,000 debt now on Oregon State aided projects, might be retired if the United States Reclamation Bureau were authorized, with consent of interested parties, to refinance the district over a long period at low interest rate and pay off the present bonds on the basis of present appraised value to be determined under the fact finder's plan. Perhaps seven to eight million dollars of such funds which might be created as a supplement to Federal Reclamation Bureau's resources, would clear up all these distressed districts and facilitate their settlement and full development.

Olin Arnspiger of Eagle Point and manager of Talent Irrigation District was elected president and Dr. W. L. Powers of Corvallis was re-elected secretary of the Congress for the ensuing year. The new trustees are: James N. Spencer for the first Congressional district, E. E. Lage, Hood River; Judge R. W. Sawyer, Bend; Peter Nelson, Redmond; Percy Purvis, Vale, for the second irrigation district. L. A. McArther, Portland, for the third irrigation district. Ralph Cowgill, James Kyle and Marshall Dana are the vice presidents elected for the first second and third irrigation districts respectively.

The next annual meeting is to be at Salem which will be convenient for the drainage section members.

Pumping Aids Seeped Areas

A plan of pumping seepage water from the earth by electric power has successfully reclaimed land in the Salt River project, Arizona, which had been unfitted for cultivation because of the raising of the ground water level through percolation from excessive irrigation and through seepage from irrigation canals.

The full text of the statement follows:

In the Salt River Valley of Arizona, as well as at a number of other places in the West, excessive irrigation, resulting in deep percolation, together with seepage from canals, has unfitted large areas for cultivation by reason of the raising of the ground-water level. These areas have increased rapidly in extent until corrective measures have become imperative.

Test borings in the Salt River project showed that about half of the project is underlaid by a coarse, water-bearing formation from which water may be pumped; and, as the Salt River Water Users' Association had available a large quantity of cheap electric power generated at its own plant, it was decided to install electric-driven pumps in wells located in the damaged areas to lower the ground-water level. This plan has been successful; water-logged land has been reclaimed; the rise of ground water in sections not yet damaged has been checked, and the pumped water has been used very largely to augment the supply available for irrigation.

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Showing the San Gabriel River and Proposed Dam Sites

Water Rights of the San Gabriel River Still Subject to Controversy

State Division of Water Rights Has on File Fifteen Applications from Various Southern California Communities

THE Division of Water Rights of the Department of Public Works of California has on file fifteen applications for water from the San Gabriel River. Many important communities and interests derive their supply wholly or in part from this source. Some of them are the Southern California Edison Company and irrigating companies diverting water at the mouth of the San Gabriel Canyon; the cities of Monrovia, Azusa, and El Monte in San Gabriel Valley; the cities of Whittier, Compton, and Long Beach and many ditch companies taking water from the Whittier "Narrows" and Coastal Plain. To determine the existence of unappropriated water the Division has been conducting an investigation since July, 1923. Some of the results of this study are given in Bulletin No. 5 and a supplemental Memorandum dated June 15, 1927.

The San Gabriel River drains 214 square miles of the Sierra Madre Mountains of Southern California. From its canyon mouth it flows out over a large ground-water basin in the San Gabriel Valley, thence through a "Narrows" between the Puente and Reppetto Hills and out over the Coastal Plain into the San Gabriel proper and the Rio Hondo. The Rio Hondo joins the Los Angeles River about 12 miles upstream from the ocean.

On the Coastal Plain there is an impermeable confining bed which creates an artesian area. The upstream limit of this bed is about five miles and eight miles below the "Narrows" on the San Gabriel River and the Rio Hondo respectively. This impermeable bed prevents the movement downward of water which might percolate from the streams and of water derived from rainfall. This resulted in an area of 34,000 acres over which the water plane was eight feet or less below the surface during October, 1926. This proximity of the water plane to the ground surface causes a large waste by evaporation and this in turn results in injury to a large area by the deposition of alkaline salts.

The existing surface rights on the River are diversions made by the water companies at the canyon mouth for irrigation and spreading and diversions made by other companies of rising ground water at the "Narrows" for irrigation on the Coastal Plain. The River in flowing over ground-water basins in San Gabriel Valley and Coastal Plain contributes to their supply by percolation into the gravels from flood flows. These ground waters are the supply for many towns, companies, and individuals.

Appropriation of water under application before the Division must necessarily be made from waste water which now flows into the ocean or more strictly speaking from water which flows beyond the upstream limits of the impermeable bed on the Coastal Plain. The determination of that proportion of the River flow which percolates and the proportion which wastes was the problem presented to the Division of Water Rights. This problem was largely solved by the installation of 23 gaging stations on the River and its tributaries. The record from these stations taken with those from 14 other gaging stations maintained by the United States Geological Survey and the City of Pasadena were used to compute the percolation chargeable to the flow at the canyon mouth.

Appropriations

Appropriations must be made in such a way as not to injure surface rights or to lessen the normal percolation into the ground water basins. Some of the applicants propose to construct reservoirs in the canyon and so operate them that the prior surface diversions at the canyon mouth will be passed and the normal amount of water tributary to the groundwater be allowed to percolate naturally and by artificial spreading; the remaining salvage water being for the applicants' use. Other applicants depend upon the operation of the proposed Los Angeles County Flood Control District reservoir to provide for normal percolation and then divert the salvage water as it is released from the reservoir. Still other applicants, who are at present pumping from ground waters, purport to be merely changing their point of diversion by applying for gravity water from the canyon. A few applications have been made by parties now using ground water, a portion of which is derived from the San Gabriel River, on the theory that by this action they are

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Recent Decision of Arizona Court Affects Water Storage in Lake Pleasant Reservoir

Prior Rights on Water Supply from Agua Fria River Amounting to 75 Second Feet Continuous Flow Given to Southwest Cotton Company

A LEGAL decision of marked importance to engineers operating within the state of Arizona, has been recently handed down by the Superior Court of Maricopa County, Arizona. The presiding officer was Judge Joseph S. Jenks.

The original suit was instituted by the Southwest Cotton Company and subsidiary interests, against the Maricopa County Municipal Water Conservation District No. 1 and the Beardsley Land and Investment Company and others.

The situation was caused by the defendant (Beardsley Land and Investment Company) building a large dam and reservoir at the base of the mountains on a site known as Frog Tanks, situated on the Agua Fria River about thirty miles above the point where it enters the Gila. The lands and properties of the defendant are south and west of the reservoir, and adjoined on the east the lands and properties of the plaintiff. The lands of the plaintiff, however, adjoin the broad sandy bed of the Agua Fria River, and it was the custom of the plaintiff to pump underground water from this sandy bed for the purpose of irrigating their properties. The entire purpose of the suit was to quiet title to rights for both surface and sub-surface waters of the Agua Fria River, and to prevent the defendants from cutting off or diverting the natural waters of the river from the plaintiff's lands.

Course of River

The accompanying map shows the conditions of the country at the time the suit was settled. The Agua Fria River, coming down from the mountainous territory to the north of the Frog Tanks reservoir, enters a fairly level and flat country approximately thirty miles above its confluence with the Gila River to the south. During the entire course of this thirty miles, the bed of the river is broad and sandy, and except during flood stages the greater portion of the stream is dry, but during the flood period the stream often covers the entire bed. At the site of the Frog Tanks dam (Lake Pleasant) there is a continuous flow of the river from the mountains, but further on down the stream, the water, especially during the summer months, disappear below the natural surface into the sandy bed, forming an underground channel. Evidence presented at the hearing showed that the defendants admitted that it was their purpose and intent, by the construction of the Frog Tanks dam, to impound to the capacity thereof, all of the waters of the Agua Fria River, both surface and sub-surface, which would otherwise pass on down the river, and to divert such waters through a canal onto the lands of the Beardsley Land and Investment Company, irrigating some forty thousand acres.

It was contended by the plaintiff that the underground waters which they had been pumping during the past years had their source in an underground stream which was fed from the waters of the Agua Fria River, that these waters were the property of the State of Arizona, and that the plaintiff had permits to appropriate these waters. In connection with the contention of the plaintiff, evidence of expert witnesses was given to show that this underground flow of the Agua Fria River followed a definite channel from points where it was absorbed to the Gila River; and that this channel or underground stream was composed of pervious sands and gravels deposited by the stream in the process of building up the valley; and that there were no other adequate sources of supply from which this underground water might originate other than the Agua Fria River.

The plaintiff showed and proved that they had been for years pumping water from these underground sources lying beneath the bed of the Agua Fria River and below the Frog Tanks dam site,

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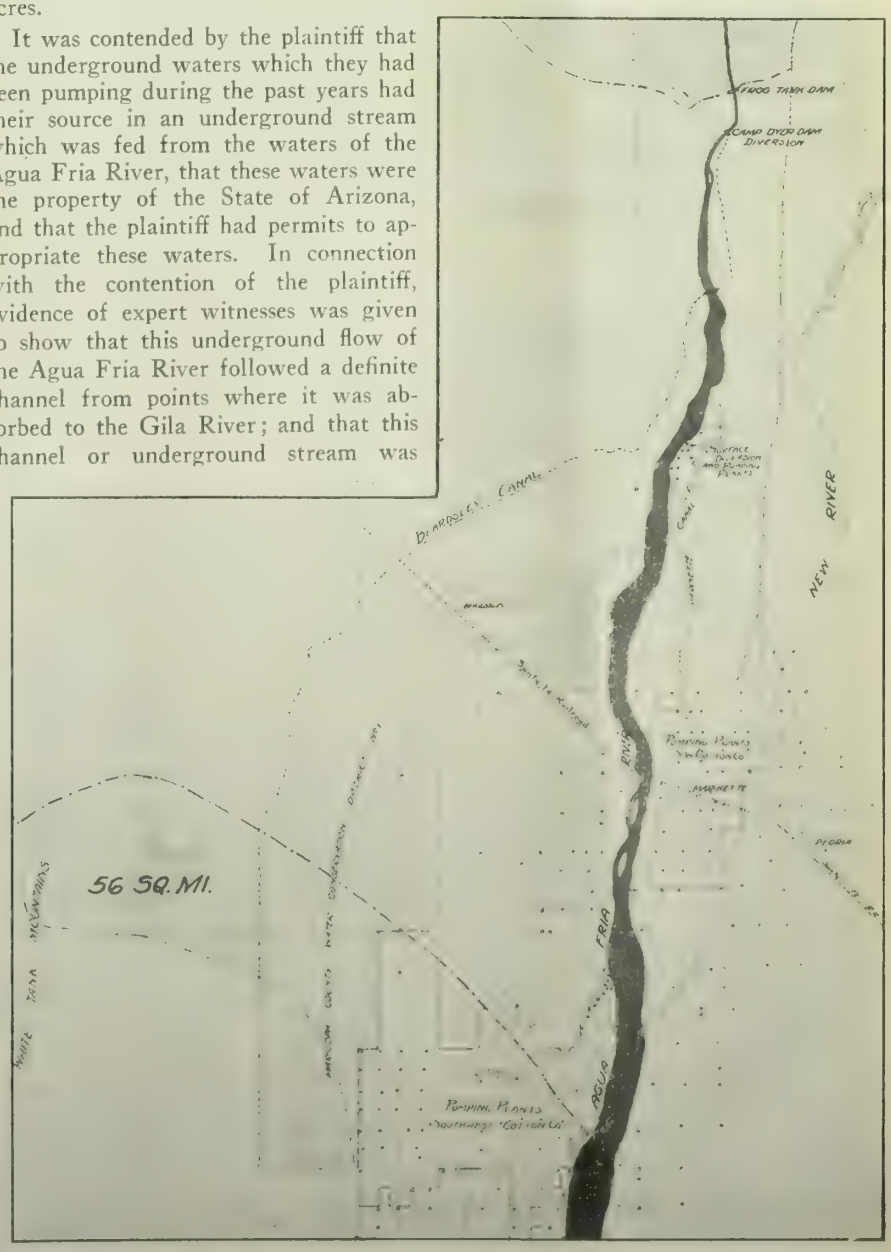

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Importance of Forests to Water Conservation

(Continued from Page 13)

under the three previous heads but it has a marked effect upon the surface runoff because it covers the soil with quantities of leaf litter, dead branches, twigs, etc. In addition to making the soil more pervious to water and covering the surface with a layer of very absorptive material it acts as an effective barrier to the flow of water. As soon as water collects anywhere on a forested slope in sufficient quantities to flow freely it carries surface material with it and the mixture of leaves, twigs, and soil particles soon dams up the little streams resulting in the formation of innumerable pools of water. Tremendous quantities of water are thus held back until it can seep into the soil. The type of forest, of course, is important and the influence will vary with species, density of stand, and other characters.

Fifth, general climatic conditions of the region which would include altitude since the former are directly influenced by the latter. It will be evident to everyone that the climatic conditions will have a marked effect upon runoff and seepage and the subject needs no further discussion at this time.

It is the difference in the condition of these five factors on different areas which are so often not given due consideration in the comparison of a forested with a denuded watershed yet they are so basic in their influence that it is wholly futile to compare two drainage basins unless all these conditions are uniform. Let us look for a moment at what happens on a forested slope as compared with one that is not forested, presupposing that the influence which the forest may exert is fairly normal and that the conditions on the two slopes are otherwise the same.

On the forested slope the falling rain first strikes the leaves and boughs of the trees. This breaks the force of the fall so that the water slowly trickles down onto the dead leaves, twigs, and humus of the forest floor. When the water reaches the humus it is taken up rapidly and held as it would be by a large sponge. When the humus becomes soaked it will gradually give up some of this water to the soil underneath. This soil has been deepened and made receptive through the addition of organic matter. The subsoil and the underlying rocks too have been broken up by the roots of the trees. By checking erosion the soil that is made in the forest is held there and the formation of an elaborate surface drainage system is prevented. If the water tends to collect into little rills it is dammed up by the dead leaves and twigs and great quantities are held until the soil can absorb it. Thus on the forested slope not only is the time allowed for absorption considerably extended but there is a deep reservoir that will take up great quantities of fallen rain rapidly and gradually allow it to seep through to the lower levels where it re-appears on the surface to maintain a regular flow in the streams.

Deforested Areas

When a heavy rain falls on a deforested slope the water reaches the soil faster than the soil can take it up. There is no layer of humus and no vessel underneath the surface ready to be filled. If the rain is at all heavy the water must collect into little rills and these join others to form streams that are soon on a mad rush down the hillside carrying away the fertile top soil, cutting ditches and gullies, and often exposing the bare rocks. Very little of the water gets a chance to seep into the ground. It flows off over the surface and reaches the rivers in such quantities that these latter cannot carry the water away as fast as it comes to them, resulting in overflow and floods. The soil that is washed away is deposited in our harbors and reservoirs where it becomes a serious menace. During the dry season these same streams often become very low and sometimes dry up entirely because there is no seepage water to feed them. The comparisons I have made between the forested and deforested slopes of course represent an ideal picture and I want to emphasize again that the various influences which the forest has on the disposition of precipitation vary with the character of the forest and the climatic and physical conditions of the watershed.

The influence of forests on snow requires some special treatment. Snow is the most important source of water in the mountainous regions. The low temperatures prevailing at the high elevations above timberline long into the summer months cause the vast accumulations of snow at these altitudes to form, under normal conditions, a regular and uniform source of water for the streams they feed throughout the greater portion of the dry season. Unfortunately, however, a great many important streams do not have their source in these alpine fields of snow and glaciers. Although there are many scientific records showing the retarding influence which the forest has on melting snow I shall give only one illustration.

Government Stations

Stations were established on both sides of the Cascades in Oregon and Washington by the U. S. Forest Service during 1916 and 1917. Ten stations were located in the forest and ten in comparable areas in the open. These studies showed that snow with a water equivalent of from 7.6 inches to 47 inches was left in the forested stations when the snow in the open had completely disappeared and that the snow in the forest lasted from two to four weeks longer than in the open. Here variations again are due to a multitude of conditions. In conjunction with the retarding influence of the forest on the melting of snow reference should be made to the fact that the soil in the forest does not freeze as readily nor as deep as in the open. This point is of considerable importance because the frozen soil cannot absorb moisture. A great deal of the water resulting from the melting of snow in the open areas cannot enter the soil because the melting takes place at a time when the soil is frozen. Under certain conditions of wet snowfall when the snow clings to the branches of the trees in such manner that a much enlarged surface is exposed to the full effects of sun and wind the forest may very considerably augment evaporation and if followed by a warm wind may even be responsible for flood conditions. We sometimes have such conditions in the Cascade Mountains when a wet snowfall is followed by a Chinook wind. We must not, however, forget that this is an abnormal condition.

Summary

"(1) The hydrological role of forests in level countries differs from that of forests in hilly or mountainous regions.

(2) In level country, where there is no surface runoff, forests, in common with other vegetation, act as drainers of the soil; hence their importance in draining marshy land and improving hygienic conditions. In such country their effect upon springs is unimportant.

(3) In hilly and mountainous country forests are conservers of water for stream flow. Even on the steepest slopes they create conditions with regard to surface runoff such as obtain in a level country. Irrespective of species, they save a greater amount of precipitation for stream flow than does any other vegetable cover similarly situated. They increase underground storage of water to a larger extent than do any other vegetable cover or bare surfaces. The steeper the slope the less permeable the soil, and the heavier the precipitation the greater is this effect.

(4) In the mountains, the forests, by breaking the violence of rain, retarding the melting of snow, increasing the absorptive capacity of the soil cover, preventing erosion, and checking surface runoff in general, increase underground seepage, and so tend to maintain a steady flow of water in streams."

(Continued on Page 45)

"Western Waterworks" Begins on Page 25 ☛

WESTERN Waterworks
Supplement to Hydraulic Engineering
Of Interest Expressly to Waterworks Executives, Contractors, and Municipal Engineers

Watershed Protection Methods Used by San Diego County Outlined by Supervisor

Paper Presented at San Jose Convention of A.W.W.A. Describes Procedure Followed by San Diego for Safeguarding Purity of City Water Supply

By R. C. WUESTE
Supervisor San Diego Impounding System

SURFACE water development in San Diego county depends upon the use of an area thirty to forty miles wide lying parallel to the coast line and about ten miles therefrom. The geology of this area is largely granitic; the mean soil cover susceptible to percolation is shallow; the topography is very rugged, lying between elevations of 300 feet to 6000 feet above sea level. The rainy period, producing run-off, begins early in December and ends in May. Only occasional erratic storms produce run-off of short duration at other times of the year. Normally then, San Diego County watersheds produce no surface flow during six months of the year and are open to the sterilizing effects of exposure to sunlight, warmth, low humidity and oxidation.

The watershed areas are semi-arid, mostly non-agricultural, sparsely settled and adapted only to limited grazing operations. Human occupancy averaged less than one inhabitant per square mile in 1915 and has not materially increased since. About 17 head of cattle per square mile was the extent of grazing operations in 1915. The greater portions of the watershed areas are still unpatented public domain and will probably remain so always.

As might be expected, run-off from rainfall on such an area may be gentle with very little suspended matter burden, or violent to the degree of carrying great quantities of eroded organic and inorganic materials. When storm run-off of 400 to 500 cubic feet per second per square mile occurs, extraneous substances reach the reservoirs from all portions of the watersheds. The floods of January, 1916, carried into the reservoirs timber and detritus indicating the stripping of many slopes to bedrock.

Self-Purification of Stored Water

Run-off must be brought to rest in the artificial reservoirs to be withdrawn as dependable, safe net yield. The mathematics of this conversion show that a given run-off volume may remain in storage in decreasing amount over a ten or eleven year period without material accretion. Whatever then the quality of reservoired water may be shortly after a harvest, its quality will be subject, over long periods, to such modifications per se as are provided by storage with natural and certain artificially applied factors operative. Most San Diego County reservoirs expose more than 1000 acres when full with average depths from 35 to 100 feet. Wind and wave action, convection, lateral circulation, oxidation in surface strata, reduction in deep strata, sedimentation, subsidence, and the bio-chemical cycle, are constantly at work.

The run-off volume resulting from a given peak season may be expected shortly after impoundment to be heavily burdened with clays, silts, salts, earth-bacteria, bacterial food, algal seeding, organic and inorganic flotsam, plankton and pollution of all kinds. Still the degree of dilution is so high that the sterilizing agencies can quickly and successfully do their work.

American sewage practice is replete with applicabilities illustrating sterilization through dilution. New Orleans, at the mouth of a river on which nine million people live, but with no major pollution six hundred miles upstream, obtains comparatively acceptable raw water from the Mississippi.

On the other hand, John R. Freeman, in his report on the Hetch Hetchy water supply plainly strikes at the time-old reliance on the more active self-purification of running water over ponded water. Allen Hazen's views on the subject in the same report support the opinion that self-purification of reservoired water is far more reliable than self-purification in flowing river water.

The U. S. Forest Service has, since the creation of the Cleveland National

One of the more recently completed structures, Barrett Dam, which adds considerable additional capacity to the impounding system of San Diego.

Forest in 1907, made effort to conserve the brush cover and meager timber stand on San Diego County watersheds. Only small attempt at reforestation and afforestation has been made. All these activities as they concern watershed areas were intended to reduce erosion, stabilize stream flow and retard silting of reservoirs. Under run-off conditions as indicated above, the success of efforts of this kind as applied locally is dubious. The success of wholesale afforestation under local climatic conditions does not appear very hopeful.

The State Board of Health, the San Diego County and City Health Departments and the Water Impounding Bureau are exercising more or less complete control over pollution influences on the watersheds, such as sewage disposal, animal and waste pollution and accidental human pollution, especially near or on territory surrounding the reservoirs. Sub-surface disposal of sewage is insisted upon, cattle and other domestic animals are prevented from having access to reservoirs and the lower reaches of affluent streams.

More complete sanitary control is carried into effect on the reservoir basins in which the watersheds terminate and where the run-off is held in retention. It is considered necessary to fence these, provide patrol against violation of commonsense decencies, keep the water under algal control and submit same to simple purification processes upon withdrawal; namely,—rapid pressure filtration, sterilization by chlorine and aeration.

Public access, under increasing restrictions, has been permitted to these reservoirs since their creation.

Recreational Use of Reservoirs

No other phase of San Diego County's principles regarding water sanitation, has come more under discussion than the one of permitting recreational use of her domestic water storage reservoirs. Every major reservoir in the County is used for this purpose. The volume of public use is increasing year by year. Public use is becoming an important side-line judged from number of patrons served and money taken in. The fact that other parts of Southern California do not afford similar fishing and hunting opportunities produces a concentration here which is making this county far-famed as a playground. The activity has been systematized and is scheduled for further development, all providing that the practice can be proven harmless to the water supply. Not enough direct data can be submitted at this time to prove the case either way. Indirect data would seem to indicate that under adequate control, the natural and artificial purification processes have kept San Diego water potable and pathogenically safe. Again, John R. Freeman, in his Hetch Hetchy Supply Report, devotes considerable space to prove that such a dual use of a supply is not necessarily incongruous or incompatible.

San Diego surface water has a mineral content similar to most Southern California waters. The physical quality of stored water at the tap has with few exceptions been notably acceptable and palatable. The safety of San Diego city water has been so unquestioned that analytical tests thereon have been rather incompletely carried out. Inaugurated by this bureau, water sampling and analysis is fast being given the attention it deserves for complete control and study of influences.

San Diego water is accepted by the Army, Navy and Marine Corps, by interstate carriers and the Bureau of Animal Industry. In ten years no local case of typhoid fever has been traceable to the water supply.

Conclusions

The following conclusions are those of the writer, and have been arrived at by application of the broadest perspective and weighing of the conflicting arguments on the question, which he has been able to bring to bear. The conclusions are supported in part or in whole by many technical men acquainted with the conditions in San Diego County. On the other hand, diametrically opposite views are taken by some. Necessarily, the writer's attitude is such that if future investigations or modifications in conditions disclose the advisability of modifying the following conclusions, no one will be more ready to change his viewpoint and recommend operation of the impounding system in accordance therewith.

1. (*General.*) Sanitary science is not an exact science and the principles thereof are subject to modification in the light of special conditions and the submittal of new data.

2. (*Peculiar San Diego Conditions.*) It may be that climate, topographic, geologic, hydrographic, agricultural and other conditions in San Diego County make possible or advisable certain modifications from standard practice of watershed protection considered inviolable elsewhere.

3. (*Brush Cover, Afforestation.*) Conservation of brush and timber cover on local watersheds has been indefinitely successful and it is questionable whether erosion over long periods of time can be hoped for to materially reduce the loosening, transportation to and final deposit of detritus in our reservoirs. The watershed areas seem not to lend themselves to extensive afforestation.

4. (*Ownership.*) Already highly expensive, from the necessity of the construction of large impounding works, local development programs will probably never contemplate the exclusive ownership of watersheds. Nor is the neces-

sity for this policy believed to exist under local conditions.

5. (*Partial Ownership.*) Effort in all case has been made to secure in ownership and control, a strip of land sufficiently wide surrounding a storage reservoir to allow for future additions to the dam, the location of peripheral patrol roads, the exclusion of residences within a reasonable distance from high-water shorelines and the detection of fluid pollution escaping from residences beyond this strip.

6. (*Grazing.*) Grazing operations in San Diego County were probably at their peak in the early part of the nineteenth century. It is not believed that the extent of the locally supported cattle industry will ever materially increase. As a health menace, cattle pollution is, of course, not to be compared with human pollution.

7. (*Mineral Quality.*) It is believed to be a far-fetched hope that mineral quality of San Diego County developed surface water may ever be modified by watershed control.

8. (*Algal Control.*) Algal control of reservoired water might be expected to be necessary in any body of water anywhere regardless of watershed control. Color, taste and odor qualify on algal control.

9. (*Bacterial Quality of Raw Water.*) Bacterial quality of San Diego County stored water has not been sufficiently studied in the past to warrant special or general conclusions. Future studies should be depended upon for the outline of control measures necessary for insurance of this phase of stored water quality.

10. (*Public Access.*) The local practice of allowing recreational use, which has drawn fire from many competent sanitarians, should in all fairness be condemned only upon the results of studies and investigations rather than on the insistence by one school of sanitarians that the practice be arbitrarily discontinued. Such studies should be comprehensive and over a sufficiently long time period to warrant conclusions.

11. (*Purity of Supply.*) The fact that purity of San Diego's water supply has been a byword for the last fifteen years under conditions as have been outlined in this paper, should certainly enter into the evidence concerning the wisdom and acceptability of local water works' practice. The record which has been established on the quality of San Diego water, together with the open question of allowing public access to San Diego County reservoirs are bound to instill a psychological incentive among local water works officials to zealously safeguard that reputation.

Lake Hodges, one of San Diego's storage reservoirs.

12. (*Watershed Protection.*) In view of everything that has been said before, it is believed that any undue increase in protective measures applied to San Diego County watersheds, exclusive of the reservoir enclosures, would at this time appear unwarranted and unjustifiable and would constitute an error in economic judgment.

California Power Board Reports Now Available

Early in 1923 there were before the Commission a number of conflicting applications for permit and license in the watersheds of the American, Stanislaus, and Trinity Rivers, California. As these proposed power developments involved diversions from one important stream to another and also affected the varied interests of domestic water supply, irrigation, navigation and flood control, it was thought best to appoint a board of engineers representing the interested Federal and State agencies to make a study of each stream, to indicate the most beneficial uses which could be made of the water, and especially to determine whether the proposed diversions from one watershed to another would be to the general public benefit. This board, designated as the California Power Board and composed of D. C. Henny, Bureau of Reclamation, Major U. S. Grant, 3rd, Corps of Engineers, U. S. Army, and E. W. Kramer, Forest Service, representing, respectively, the Departments of Interior, War and Agriculture; and W. F. McClure, State Engineer and Director of Public Works of the State of California, represented on the board of Paul Bailey, deputy State engineer, after field investigations and public hearings prepared and submitted separate reports on each of the three streams, in 1924.

Numerous requests for copies of these reports have led the Commission to have two of them printed. The report on the Stanislaus has been available for several months, and the report on the uses of the American River can now be had by those interested, without charge. The American River report contains in addition to the findings and conclusions of the board, as a whole, four appendixes:

1. A general description of the river basin.

2. A study of power possibilities and comparison of the various plans for inter-tributary diversion, including estimates of available storage, regulated flow and power capacity.

3. A description of the irrigable lands concerned and their water requirements and an examination of the soils and agricultural possibilities of these lands.

4. A discussion of the effect of the proposed developments on navigation, flood control and industrial uses, including hydraulic mining.

The publication includes 54 pages of text, 12 tables of run-off data and power estimates, and five maps.

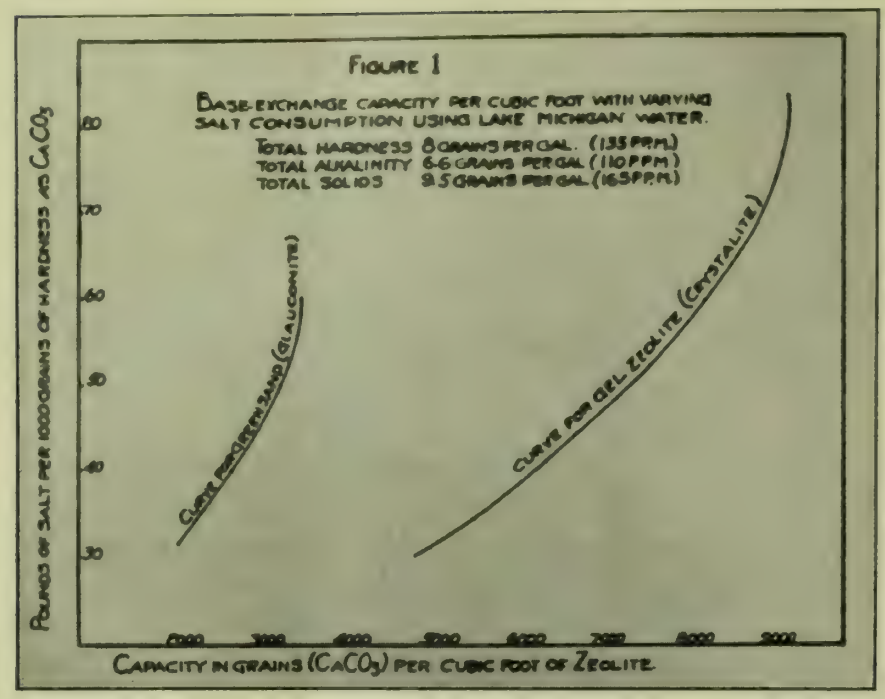


FIGURE 1
BASE-EXCHANGE CAPACITY PER CUBIC FOOT WITH VARYING SALT CONSUMPTION USING LAKE MICHIGAN WATER.
TOTAL HARDNESS 8 GRAINS PER GAL. (135 P.P.M.)
TOTAL ALKALINITY 6.6 GRAINS PER GAL. (110 P.P.M.)
TOTAL SOLIDS 9.5 GRAINS PER GAL. (165 P.P.M.)
POUNDS OF SALT PER 1000 GRAINS OF HARDNESS AS $CaCO_3$
CURVE FOR GREENSAND (GLAUCONITE)
CURVE FOR GEL ZEOLITE (CRYSTALITE)
CAPACITY IN GRAINS ($CaCO_3$) PER CUBIC FOOT OF ZEOLITE

Recent Developments in the Zeolite Process of Water Softening

By A. S. BEHRMAN

THE base-exchange properties of zeolites were discovered by J. Thomas Way[2] in 1850, in the course of his researches on fertilizers. Rather interestingly he describes the synthesis of zeolites by two of the same reactions used today—i. e., the reaction of sodium silicate with sodium aluminate on one hand, and with aluminum sulfate on the other.

The first effort to utilize commercially the base-exchange property of zeolites was made by Harms,[3] who used a siliceous earth for the removal of potash from beet-sugar juice, in order to increase the yield of crystallizable sugar. A good deal of work was done along the same line, and apparently much more scientifically, by Rumpler,[4] who worked with synthetic precipitated zeolites and those occurring in Portland cement.

The application of zeolites to water purification did not receive attention until the first decade of the twentieth century. There appears to have been some little discussion between Rumpler[5] and Gans[6] as to who should get credit for the suggestion; but this argument does not concern us here.

Regardless of whether Rumpler or Gans suggested water-softening with zeolites, it is fairly certain that Gans and his organization made the first usable synthetic materials that were actually employed for the purpose on a practical scale; and in 1906 obtained a process patent[7] for the softening of water by means of zeolites. The zeolites used were made by fusion of appropriate raw materials. After the usual period of experimentation, products were finally obtained which were generally satisfactory according to the only standards then prevailing.

These zeolites, however, were quite slow acting. In consequence, water could be run through a bed of such material only at a comparatively slow rate if complete softening was to be secured; and by the same token the period of regeneration was also lengthy. It was the standard practice to require a softening period of 8 to 12 hours, and a regeneration period of similar duration.

Obviously, with such slow-acting zeolites, high peak loads and suddenly increased demands for soft water could be met only by the alternative expedients of using an apparatus large enough to have a normal capacity equivalent to the peak load required, or by providing sufficient storage of water softened at the slower rate to carry over the peak period. Either alternative had its obvious objections.

Another objection to the fused type of synthetic zeolite was its susceptibility to attack by certain kinds of water, particularly those with large amounts of free carbon dioxide. The effect of this attack was a gradual disintegration of the zeolite into more or less gummy and gelatinous particles which were unsuited mechanically as well as chemically for water-softening.

A few years after water-softening with these synthetic zeolites was introduced into the United States, a bentonitic clay was found which possessed marked base-exchange properties. This clay, when processed into particles of appropriate size, baked and rehydrated, yielded a very satisfactory softening material —satisfactory again, by the then prevailing standards, since it was also a relatively slow softening, slow regenerating material, with attendant limitations.

The next development in zeolite water-softening, which was fast becoming a keenly competitive field of chemical engineering, was the introduction of New Jersey greensand, or glauconite, as the softening medium. This marked a distinct advance, for greensand is much more rapid in its action than either of the older zeolites, so that considerably greater softening rates and much shorter regeneration periods could be employed. High peak loads could be carried, making unnecessary the use of extra softening or storage capacity. It is true that the useful capacity of greensand between regenerations was materially less than that of the older materials—about 3000 grains of calcium carbonate equivalent per cubic foot as compared with 4000 to 5000 for the older materials—but regeneration could be accomplished in such a short time—a half hour, or even somewhat less—and with such economy of salt, that the lesser total capacity was of comparatively small importance.

One other type of zeolite that deserves mention is the precipitated type. In making materials of this class the zeolite is prepared as a gelatinous precipitate, under carefully controlled conditions to secure proper precipitation.[8] The precipitate is then filter-pressed and otherwise treated, and finally dried.

The foregoing description represents pretty accurately the state of the art up to perhaps about three years ago, as far as the major factors in the industry are concerned.

Nature of Synthetic "Gel" Zeolite

The most recent development in zeolites is a type of synthetic zeolite which we will designate for convenience as the "gel" type. Although Bancroft[9] includes in the category of gels both gelatinous precipitates and jellies, common usage in the synthetic zeolites and related arts

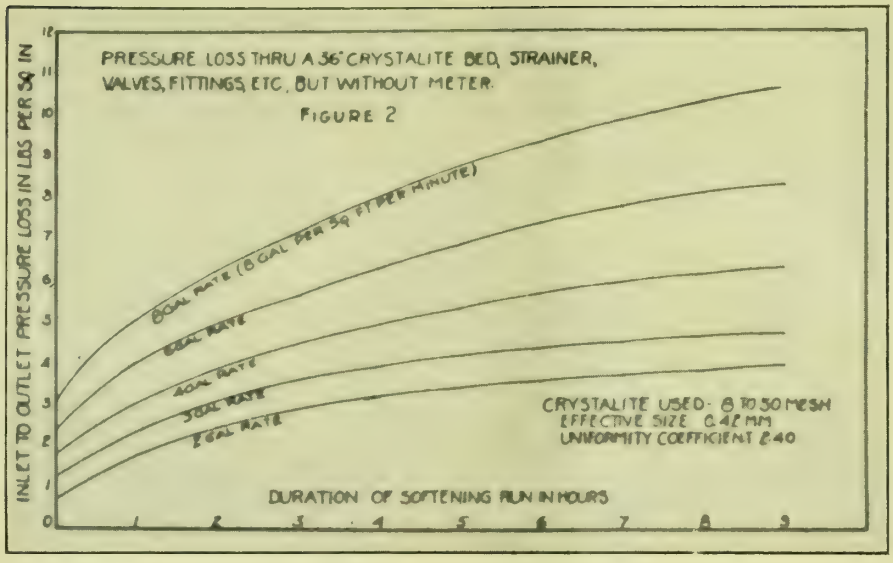
Presented before a recent meeting of the American Chemical Society Division of Water, Sewage, and Sanitation Chemistry.

sanctions the use of the term "gel" for jellies and not for gelatinous precipitates.

If solutions of sodium silicate and aluminum sulfate[10] or of sodium silicate and sodium aluminate,[11] of proper concentration are mixed in the proper proportion and under the proper conditions, no precipitate is formed. Instead, the whole mass gradually sets to a stiff and homogeneous gel embracing all the constituent elements of the reacting solutions. This gel has such great rigidity of structure, and is relatively so low in water content—comparing favorably in this respect with a gelatinous precipitate which has been vigorously filter-pressed—that it may be dried directly. It then breaks down into small lumps which, when placed in water, graduate into particles of a size frequently suitable for water-softening without crushing or grading.

The fact that a granule of this type of zeolite is a fragment of a strong and homogeneous structure, and not a compacted agglomeration of small precipitated particles, is undoubtedly responsible for some of its distinctive properties and probably accounts for its classification as the gel type. The manufacturing advantages in making a gel-type zeolite are more or less apparent and will not be discussed here.

Properly prepared zeolites of the gel type, particularly when made with aluminum sulfate as the source of aluminum, are very hard and durable. They possess high base-exchange capacity and are extremely rapid in their softening and regenerating actions. Incidentally, the use of aluminum sulfate instead of sodium aluminate in the preparation of high-capacity zeolites is a direct refutation of the theory of Gans and his followers, that high-capacity, useful materials could not be prepared if the aluminum is derived from aluminum sulfate or other compound in which aluminum forms a positive ion.


PRESSURE LOSS THRU A 36" CRYSTALITE BED, STRAINER, VALVES, FITTINGS, ETC. BUT WITHOUT METER.
FIGURE 2
INLET TO OUTLET PRESSURE LOSS IN LBS PER SQ IN
8 GAL RATE (8 GAL PER SQ FT PER MINUTE)
6 GAL RATE
4 GAL RATE
3 GAL RATE
2 GAL RATE
CRYSTALITE USED- 8 TO 30 MESH
EFFECTIVE SIZE 0.42 MM
UNIFORMITY COEFFICIENT 2.40
DURATION OF SOFTENING RUN IN HOURS

Advantages of Gel Zeolite

A brief review of the more important characteristics of a typical gel zeolite, such as crystallite (prepared from sodium silicate and aluminum sulfate), will make clear the reasons for the great and increasing importance of the gel type in present-day water-softening.

Softening Capacity Between Regenerations—The economical softening capacity of a good gel-type zeolite is 6000 to 9000 or 10,000 grains per cubic foot (13.9 to 20.9 or 23.3 kg. per cubic meter) depending on the conditions of its use.

The term "economical softening capacity" deserves a word of explanation. The amount of base-exchange capacity actually employed in water-softening is always less than the total capacity of the zeolites. There is a certain capacity, however, which is most economical to use, chiefly from the standpoint of minimum salt consumption, just as in the case of a locomotive there is a certain most economical speed. Beyond this range and up to the limit of ultimate capacity, the use of more salt makes available more exchange capacity but at the price of a greater salt consumption per unit of softening capacity.

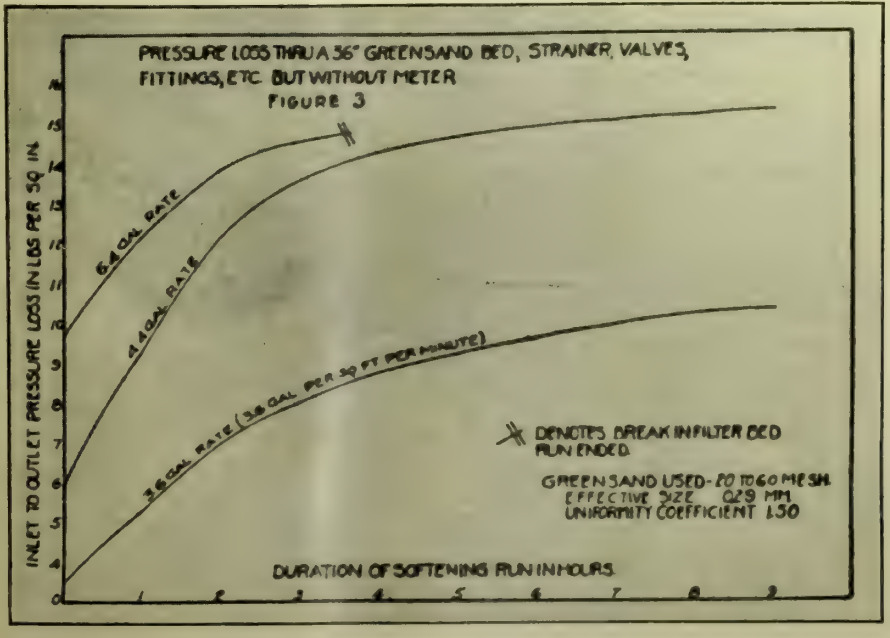
In zeolites of the gel type there is a large latent capacity which may be called into service by the expenditure of more than the most economical amount of salt. In consequence a softening unit using a gel-type zeolite like the one referred to, installed to operate on the basis of a very economical salt consumption, and which has high capacity between regenerations even with that consumption, is capable of providing for a considerably increased demand of soft water simply by increasing the amount of salt employed (Figure 1).

Frequency of Regeneration—The frequency of regeneration obviously varies inversely wtih the softening capacity. The high capacity of the gel-type zeolite is therefore very advantageous in this respect.

Water Consumption for Regeneration—The amount of water required for washing the zeolite bed free from the brine used in regeneration is often quite an important item in operating expenses. It appears to depend entirely on the area of the bed, the depth of bed being immaterial within the usual limits. The smaller area possible with the gel-type zeolite accordingly reduces the water consumption for this purpose.

Softening Rates—It has already been pointed out that the older zeolites were limited in their industrial usefulness by the slowness of the rate of base-exchange

(Continued on Page 34)


PRESSURE LOSS THRU A 36" GREENSAND BED, STRAINER, VALVES, FITTINGS, ETC. BUT WITHOUT METER
FIGURE 3
INLET TO OUTLET PRESSURE LOSS IN LBS PER SQ IN
6.4 GAL RATE
4.4 GAL RATE
3.6 GAL RATE (3.6 GAL PER SQ FT PER MINUTE)
DENOTES BREAK IN FILTER BED RUN ENDED
GREENSAND USED- 20 TO 60 MESH
EFFECTIVE SIZE 0.29 MM
UNIFORMITY COEFFICIENT 1.50
DURATION OF SOFTENING RUN IN HOURS

METERS & METERING

Action of Vertical Axis Meters When Subject to Stream Flow Variations

By PAUL E. HOFF

THE turbine rotation of a vertical axis meter, at rating stations, is the result of horizontally approaching stream forces and the ratings are accordingly. Experiments have proven that vertical axis meters rotate normally, when exposed to stream forces of any direction. This means, that the meter indications are not the result of the forward components, but of the maximum of their forces, regardless of direction. Thus a meter of that type ordinarly over-rates, as parallel stream lines are rarely met in open streams.

The rotation of a vertical axis meter is of necessity slow as compared with the stream velocity. The meter turbine, being bound to a certain path, only one-half of which is favorable to the stream flow, offers considerable resistance to the stream, the effect of which is reflected in the meter action. This is a condition due to the meter design and not to instrumental friction.

In view of the almost perfect bearings, the flow obstruction of a vertical axis meter is relatively the same at all stream velocities, yet the rating curve indicates that in decreasing stream velocities at about 2 ft. per sec., a proportionally greater decrease of turbine rotation begins. It is difficult to conceive that any other disturbing influences than eddy formation could be the cause, except perhaps viscosity. Whether or not the eddy influences are regular, has not yet been determined. If they are at rating stations, they are certainly not in open streams because of irregularity of flow.

Considering the amazingly small forces involved at low velocities (velocity of 0.1 ft. per sec. exerts a pressure equal to that of a column of water 0.002 inches in height), it is very questionable whether a current meter can produce reliable indications as long as the presence of influences, which oppose normal meter actions, can be traced at the rating curve. A mere shifting of a hand supported meter is apt to produce a greater force to influence meter rotation erroneously.

The sensitiveness of a meter as demonstrated by its rotation in very low velocities, is in no way an indication of a meter's usefulness or of any other high qualities for low velocity operations, from which eddy influences cannot be separated. The vertical axis meter is not qualified to be used for vertical integration as a method to determine mean velocities of streams, its tendency to rotate in normal direction, when exposed to vertical stream forces, prevents reliable meter indications. Aside from this, surface influences retard the meter rotation when the meter approaches the surface.

Vertical axis meters are intended to be used as rod suspended meters in smaller streams and canals. For larger channels and rivers the cable suspension is most convenient.

Rigid meter position is essential for reliable meter action. The flow interference of vertical axis meters is responsible for the difficulty of maintaining a stable meter position. The operator may estimate the degree of reliability of his work by the stability of his meter position while the meter is in operation.

Guernsey Surge Tank Cares for Uneven Flow

(Continued from Page 20)

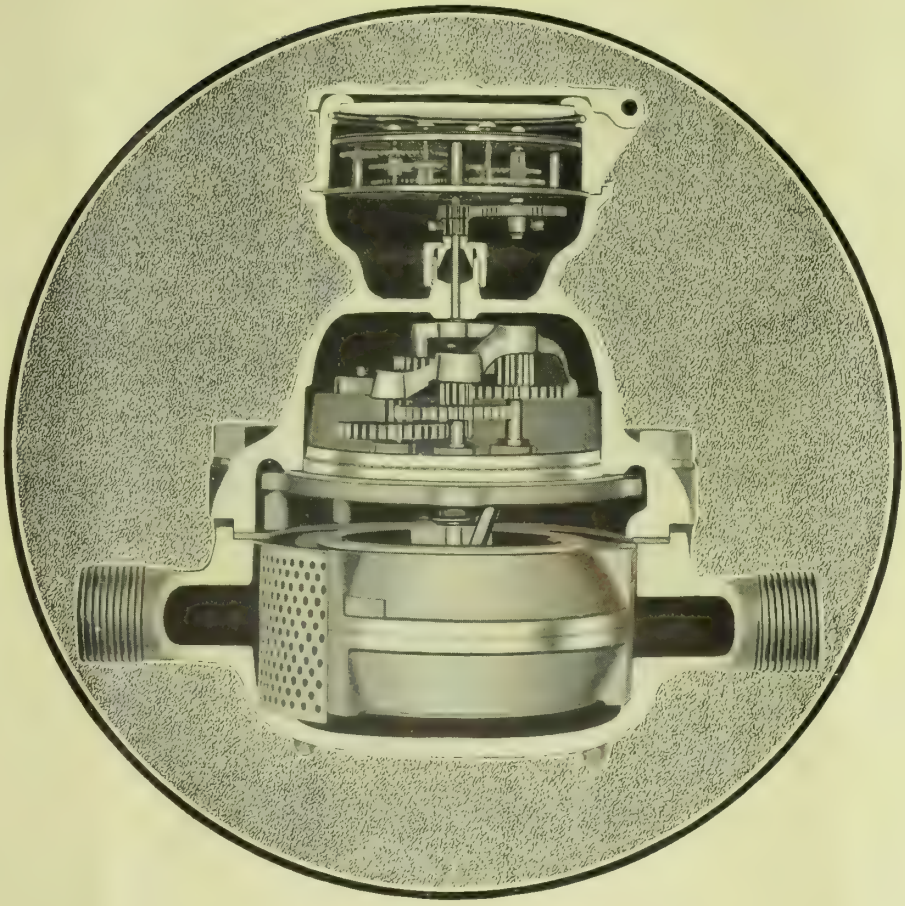
undertaking in itself, since the mathematics is very much involved. The fundamental physical relations governing the action of surge tanks are expressible in two parametric differential equations of the first order, involving the three variables—tunnel velocity, departure of water surface from the normal level in the surge tank, and time. These equations are of peculiar interest to the mathematician since they apparently belong to that class of equations for which no general solution is known. For any particular case, a close approximation to the correct solution may be found by applying the original equations successively over small increments of time. This method is laborious in the extreme and is made doubly so because the desired dimensions can not be solved for directly but must be found by cut and try.

Problems of Design

The mathematical difficulty is due to the fact that the frictional resistance to the flow of water is proportional to the square of its velocity, since if the assumption be made (at the expense of accuracy) that the resistance is proportional to the first power of the velocity the equations become manageable and if the frictional resistance be neglected entirely they are easily solvable. The simplicity of the formulas derived on the above bases and the known fact that they give, or can be made to give, results on the safe side, have gained them a wide acceptance among engineers. This is especially true in the case of the formulas derived by neglecting the friction entirely, because by their use the size of tank required can be solved for directly. It is also usually possible to design the penstock and connection so that the condition of negligible friction assumed is substantially justified in fact, it being highly desirable to reduce friction in the flow line in any case to save power.

Mathematical Difficulties

It has come about, therefore, that the peculiar mathematical difficulties have caused an important point to be obscured, which is, that friction properly employed may here be turned from a liability into an asset, and may be used not only to decidedly decrease the size of tank required but to improve its operation. These two desirable features are secured in this case, not by increasing the friction to flow in the power tunnel or penstocks but by throttling the connection between penstock and surge tank sufficiently to introduce a calculated amount of resistance to flow. This resistance does not interfere in the least with the normal operation of the turbines, but does materially reduce the amplitude and duration of the surges caused by changes of load. An experienced turbine manufacturer recommended a tank of 35 feet diameter for this installation, based presumably on the accepted formulas and practice. A comparison of the 35-foot open tank with the 22-foot throttled tank shows the profound effect of providing resistance to flow in the surge tank connection. In this case it is provided by bolting an annular ring to the top of the connection to the surge tank, thereby restricting the area through which the water must pass on entering or leaving the tank.



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STORAGE & DISTRIBUTION

Welded Steel Pipe Lines Extensively Used by Southern California Cities

City of Monterey Park Has Recently Installed an Entirely Welded Pressure Water Line Nearly Two Miles in Length

By O. A. GIERLICH
City Engineer of Monterey Park, California

THE City of Monterey Park is located in that fast growing territory known as the "East Side" of the City of Los Angeles and is only five miles from the center of the city.

Within relatively few years the City of Monterey Park has grown from a community of little farms to a thriving up-to-date city of approximately 7,500 population, with a flourishing business district. In 1922 the population was estimated at 3,500, which indicates an increase of over one hundred per cent in the past five years and which places Monterey Park among the fastest growing cities in California. Naturally this rapid growth placed a heavy burden on the municipal water department, keeping up with the enormous growth and rapid increase in demand.

In 1922 the city voted a $225,000 bond issue for the purpose of purchasing the private water system from the company then serving a district including the city, and also to construct a one million gallon reservoir, to replace a portion of the water mains in the built-up sections of the city and to increase the water supply. Water-bearing land at that time was purchased in the San Gabriel basin two miles east of the city. A 10-inch main was installed from this plant to the city's distribution system.

By 1926 this system was out-grown. Additional storage and supply main capacity was required and a second bond issue of $180,000 was voted. A reinforced concrete reservoir of two million gallon capacity is being installed, over twelve miles of distributing mains from four to twelve inches in diameter are being constructed, a new well was drilled at the site of the old plant inside the city, the existing ten-inch main was supplemented by the construction of a fourteen-inch supply main from the San Gabriel plant, and an additional booster pump of 800 G. P. M. was installed.

The major portion of this pipe line is located in extremely hilly section with heavy slopes, the pipe line crossing beneath several creeks which carry a heavy flow of storm waters during the rainy season.

Approximately one-half of the line is under a pumping head of 300 to 375 feet. It was originally planned to construct this line of cast iron pipe. Owing to the extreme heads, the heavier and more expensive classes of pipe would have been required. Alternate bids were called for on several types and sizes of pipe and the contract was awarded to Western Pipe and Steel Company of California for 3-16-inch welded steel plate pipe with soil proof wrapping.

In comparing the bids it was found that the saving in cost in using this class of pipe permitted an increase in the diameter of the main as originally planned, from twelve-inch to fourteen-inch, with a saving of several thousand dollars from the amount originally set aside for this line.

One of the questions in the writer's mind at the time of contemplating the use of welded steel pipe was the problem of replacing the asphaltic dip coating on the inside of the pipe where same was removed by the field welding.

It was specified that the award of the contract would be subject to demonstrations made in the shop under actual field conditions to satisfy the writer and the water superintendent that this coating could be replaced satisfactorily.

It will be of interest to describe the method that was finally adopted after several spraying devices and types of metal coating had been tried out. Experiments were conducted by the engineers and shop foreman of the Los Angeles plant of the Western Pipe and Steel Company. The one finally adopted was found to replace the inside coating over the field welds in a most satisfactory manner as follows:

After experimenting with various paints, a liquid metal paint, with an asphaltic base that flowed freely under pressure and dried quickly, was finally selected. The sprayer consisted of a pressure paint pot under seventy-five pounds air pressure fed through a flexible rubber hose, attached to a half-inch galvanized pipe measured to the length of section. The spray nozzle fastened to the end of the pipe was a circular cap with numerous fine holes drilled in the outer circumference.

The pipe was set on guides which centered the spray nozzle and by drawing same back and forth within the pipe and at the same time revolving the spray, a complete coating of asphaltic paint was placed over the weld. On several occasions a weld located sixty feet from the open end of the pipe was successfully coated.

The pipe was placed across the dry creek beds with a minimum cover of six feet. A concrete jacket ten inches in thickness was placed around the pipe, which was carried up the slopes of the banks to a point well above high-water mark. Air relief valves were placed at points in the line where required and fourteen-inch valves were installed approximately every half-mile.

As one-half of this line was constructed across private property over an easement, in order to provide easy access to the gate valves, standard precast reinforced concrete manholes were placed over the gate valves, with standard manhole covers. The system of installing manholes is also being followed in the distribution system on all gate valves twelve inches or over.

The excavation and backfilling was done under separate contract, the minimum cover over the pipe being three feet in the roadway and four feet long private property. The maximum depth was twelve feet on the bank of the stream and one manhole was installed at this depth.

Rapid progress was made on the work, considering the nature of the terrain in which it was constructed. Approximately twenty-five working days were required to lay the 9,000 feet of line. This is exclusive of delays caused by reason of crossing the stream beds, where ground water was encountered, which required the operation of a trench pump.

R. F. Walter, chief engineer of the Bureau of Reclamation, spent a week during October at Albuquerque, New Mexico, with the consulting board of the middle Rio Grande conservancy district, going over the plans of the district which proposes to irrigate lands in the Rio Grande Valley between White Rock Canyon and San Marciel.

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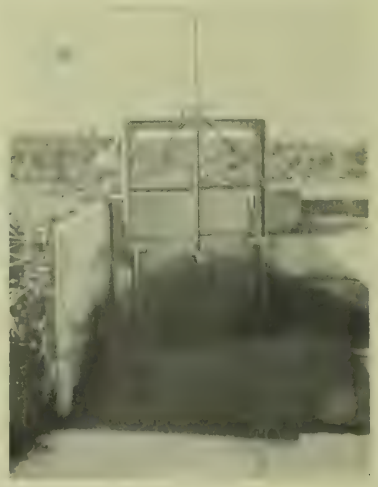
Combination Automatic Drain and Slide Headgate

California Culvert Company Designs New Headgate Which Has Many Interesting Applications

The wide and successful use of the Calco automatic drainage gate for the reclamation of marsh lands, the elimination of mosquito breeding areas, the retention of salt impregnated waters in salt works ponds, and the maintaining of desired levels in duck ponds has led to the designing of the Calco Automatic Drainage and Headgate Model 1001 for use where the automatic features of the drainage gate and the water control enabled by the slide headgate are essential.

For reclamation of marsh lands and mosquito abatement work the Calco automatic drainage gate is used to drain the land and prevent back-flow. Outward drainage is desired only.



In salt works and duck ponds, it is necessary to allow the tide or other high waters to enter the ponds and prevent out-flow—just the opposite from the function of the gate in reclamation and drainage work. In the first instance, the gates are placed facing the tidal or other high waters, and in the second they are facing the inside or basin side of the ponds.

The Calco Automatic Drainage and Headgate Model 1001 enables retention of waters in salt works and duck ponds and in addition makes it possible to empty the water from these basins at will. In salt works, a series of receiving ponds may be constructed with these combination gates placed facing away from the tide in each pond, thus making possible the maintenance of several smaller basins and enabling more rapid evaporation.

In the maintenance of duck ponds, it is sometimes desirable to drain them for removal of tule or other growth. Here the control allowed by this combination gate is appreciated.

Where low-lying lands are drained into rivers or other bodies of water and are protected from floods by levees, there is danger at times from floods. Since reflooding over these embankments also means their washing away, the damage thus done amounts to hundreds of dollars. The Calco Automatic Drainage and Headgate installed in these levees enables voluntary reflooding of the land when tides or rivers are high thus saving the embankment.

Use of Synthetic Gels in Zeolite Water Treating Process

(Continued from Page 29)

action. With the gel-type zeolite referred to, this action is so rapid that softening rates may be employed which are greatly in excess of those previously possible.

This greatly increased rate of exchange may be utilized to advantage in several ways, of which two are extremely important: (1) softeners of much smaller area may be used than would otherwise be necessary; (2) sharply increased peak loads may be carried without difficulty.

Loss of Head

In downflow softening—that in which the water being softened passes through the zeolite bed downwardly—an extremely important engineering factor is the loss of pressure through the zeolite bed. With some types of zeolites this loss of pressure is frequently so serious that the additional pumping necessary in consequence is an appreciable item. With a gel-type zeolite the loss of head is relatively quite small. Figures 2 and 3 show graphically the difference in behavior in this respect of a gel-type zeolite and greensand. The reason for the difference is readily found. The particles of greensand are quite small—practically all are finer than 20 mesh, and particles down to 60 mesh are commonly employed. The granules are rounded and rather regular. The combination of these two characteristics accounts for the decided tendency of a greensand bed to pack, and to "channel"—that is, to break through at points of least resistance in the bed. With the gel zeolite, the particles are relatively large—the material used in the tests shown is 8 to 50 mesh—and are iregular and sharpedged. The packing tendency is thus minimized.

Adaptability

As Siedler,[12] one of Gans' co-workers, pointed out, softening with zeolites may be either upward or downward. This is

"We Made a Serious Mistake"

says the waterworks superintendent whose water-filled trench stopped his work.

"by not ordering PRECALKED pipe instead of open bell."

But read his letter:

The car load of pipe was received in fine condition and must say that we are much pleased with your pipe especially regarding the ease with which it can be handled as compared with heavier pipe.

However, we believe we made a serious mistake by not ordering the precalked pipe instead of open bell as we have run into some very wet sandy digging, and are having considerable trouble in pouring our joints. We are confident this is the ideal place to use precalked joints, but as we had some joint material on hand which we wanted to use up and as these pipe laying conditions are unusual here, we ordered the open bell pipe. Precalked pipe would look mighty good to us on this job.

Yours truly,

Supt. of Water Works.

In contrast to this, see the pipe-laying proceeding uninterrupted and the enthusiastic report of another Superintendent who uses PRECALKED pipe.

We have most of the pipe laid and I wish to say that it is the fastest and best laying pipe that I have ever used. We never could have used the other pipe where the joints had to be run for we struck water in the trench in some places and find that your pipe can be laid in water almost as fast as in a dry trench.

Very truly yours,

Signed

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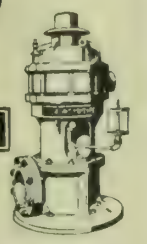

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particularly interesting in view of some court decisions in this country which indicate that downward softening is the only feasible method. Siedler was right. As a matter of fact, for fairly soft waters upward softening is the only practical method, particularly in using high-capacity, rapid-rate zeolites of the gel type. In the case of extremely hard waters, this has not yet been shown to be true.

Several months ago several large softening units were installed in Chicago, all at about the same time, to operate with the gel-type zeolite referred to on Lake Michigan water, which has a hardness of 8 grains per gallon (135 p. p. m.). Using downflow softening, for which these plants were originally designed, it was found that a comparatively low total base-exchange capacity could be obtained with economical salt consumption. The direction of flow was then reversed so that the water passed upwardly through the zeolite bed, whereupon the softening capacity was increased by one-third, with the same salt consumption per unit of hardness as before. These improved results have been maintained consistently since the change was made. Another advantage of upflow softening was that the loss of pressure through the zeolite bed was practically zero. Rates as high as 10 or 12 gallons per square foot per minute could be satisfactorily employed.

"Porosity"

The high capacity and rapid rate of exchange in the gel zeolite are sometimes ascribed to its "porosity," or high adsorptive capacity. There is undoubtedly a relation between structure and available capacity, at least, a relation which is not clearly understood, in spite of what might appear to be an obvious connection. Another factor largely responsible for the distinctive physical and chemical properties of the gel-type zeolite is the flexibility in composition which the preparation of this type of material permits.

Whatever the exact nature of the pores in the gel zeolite, they must be ultra-microscopic, since particles of the gel are perfectly transparent when viewed under a high-powered microscope. Furthermore, softeners equipped with the gel zeolite have been in use for long periods of time on waters containing considerable amounts of iron or other finely divided colloidal matter, such as silt, without loss of capacity.

Greensand, which is a base-exchange material still being synthesized by nature on the ocean floor, is also quite porous, though to a lesser extent than the typical gel zeolite. Greensand dried at 100° C. will take up about 15 per cent of its weight in water. Since the specific gravity of greensand is about 2.2, it is readily calculated that the "pores" in greensand actually occupy very nearly one-third of its total volume.

The use of a colorless zeolite obviously eliminates the possibility of "brown water" or "green water," which has been a source of complaint in a number of greensand installations, owing to a very slight disintegration of the mineral. This has been true particularly in domestic or similar installations in which the softener has been alowed to stand idle for considerable periods of time.

Conclusion

The development of the gel-type zeolite has been a substantial contribution and step forward in the art of zeolite water-softening. By its use it has been possible to fulfill the demands of modern industry for greater softening capacity, extremely high rates of exchange, and economy in maintenance and operation.

[2] J. Roy, Agr. Soc., 11, 313 (1850); 13, 123 (1852).
[3] German Patent 95,447 (June 2, 1896)
[4] Deut. Zuckerind. 26, 585, 625 (1901).
[5] Centr. Zuckerind., 16, 172 (1907-08).
[6] Ibid., 16, 373 (1907-08).
[7] German Patent 197,111 (1906).
[8] Boehringer and Gessler, U. S. Patent 1,050,204 (January 14, 1913); de Brunn, U. S. 1,161,200 (November 23, 1915); Rudorf, U. S. 1,304,206 (May 20, 1919).
[9] "Applied Colloid Chemistry," p. 162, McGraw-Hill Book Co., 1921.
[10] Behrman, U. S. Patent 1,515,007 (November 11, 1924).
[11] Wheaton, U. S. Patent 1,586,764 (June 1, 1926).
[12] Rept. 7th Intern. Congress Appl. Chem., p. 262 (1909).

New San Francisco Office

The Pacific States Cast Iron Pipe Company announces the opening of its new sales office at San Francisco, in charge of V. H. Doyle. The new office will be located at 922 Hunter-Dulin Building, and its territory will comprise northern California and western Nevada.

The Pacific States Cast Iron Pipe Company manufactures cast iron pressure and soil pipe—the former by the McWane processes—and has a large foundry at Provo, Utah, with sales offices located at Los Angeles, San Francisco, Portland, Provo, and Salt Lake City. The company celebrates this month the completion of the first year of its operations at Provo.

Design and Construction of McKay Storage Dam

(Continued from Page 15)

lava rock in the right abutment. The spillway structure consists of a double-barrel siphon, the throat of each unit being 8 feet 6 inches wide by 2 feet 6 inches high and six 20-foot by 10-foot motor-operated radial gates designed to pass 10,000 second-feet with reservoir surface at top of the gates. Two of the radial gates are automatic, being con-

trolled by float switches located in wells in the adjacent piers. The gate-operating mechanism is located directly over the gates on a reinforced concrete deck.

The spillway excavation of 31,000 cubic yards of rock was drilled with jack hammers, shot, moved to the lower end of the spillway with a power-operated drag bucket, and loaded into 4-yard dump cars and placed in the rock drain at the downstream toe of the embankment.

Concrete Aggregates

Sand for concrete was not available at the dam site and was shipped by railroad from Hermiston, a distance of 42 miles, and hauled by truck 2½ miles. The cost at the mixer was $2.50 per cubic yard. Gravel for concrete was obtained about 1 mile above the dam. The cost of excavating, screening, washing, crushing, and hauling to the mixing plant was estimated at $1.80 per cubic yard.

Extensive tests were made by the Bureau of Standards in Denver on various available aggregates for concrete before the decision was reached to use local gravel and Hermiston sand. All sands in this region are rather fine and very poorly graded. The resulting mixed aggregate was deficient in coarse sand and pea gravel. This deficiency was later corrected to a certain extent by the addition of local aggregates selected for this purpose.

The accompanying drawing shows the general plan and sections through the spillway, outlet, works, maximum section, and various details. The tabulated cost gives the actual construction quantities, unit costs, and both the estimated and actual total cost.

Organize New Motor Company

Carl E. Johnson, formerly vice president of the U. S. Electrical Mfg. Co., of Los Angeles, has organized the Sterling Electric Motors, Inc., to manufacture a new line of electric motors and motor specialties which, the company states, will incorporate some new and novel ideas. Associated with Mr. Johnson as officers of the new company and in active management are J. M. Sharp, Earl Mendenhall, Allen A. Adams and Horace S. Walling who were formerly president, chief engineer, superintendent and sales engineer respectively of the U. S. Electrical Mfg. Co.

Ed Healy, of the New Mexico State engineer's office, has been engaged in staking out the site for a reservoir to cost $100,000 at Talpa, in the Taos valley, New Mexico.

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WATER PURIFICATION

Chlorine Absorption Characteristics of Various Kinds of Waters Studied

Investigations Show Different Types of Waters Have Radically Different Absorption Values for Chlorination

By JACOB R. MEADOWS AND HARRISON HALE

INASMUCH as a greater part of the chlorine absorbed, as indicated by the chlorine absorption test, is used in oxidizing some organic matter and other oxidizable substances in water, it would seem probable that such a test should give values comparable with the oxygen-consumed value (1) which is used as a standard method in determining the capacity of a water to be oxidized, and hence an indicator as to the carbonaceous organic matter it contains.

The purpose of this investigation has been to compare the permanganate method of oxygen consumed in water analysis with that of the chlorine absorption test by different waters. In doing so, it was hoped that a correlation would be found which would permit the use of the amount of the chlorine absorbed by a given water to determine in a large measure its organic content.

The use of the chlorine absorption test has been studied by Wolman and Enslow (2), and the fact that the five-minute chlorine absorption test would compare very favorably with the permanganate test under certain conditions was shown. Their data disclosed a fairly close variation of chlorine absorption with the oxygen-consumed values of different supplies. They found that the five-minute rate of chlorine absorption shows a decreasing acceleration with increases in pollution as measured by an increase in the oxygen-consumed values. Froboese (3) has investigated the capacity of water to decompose hypochlorites and maintains that this determination is of value in addition to its oxygen-consuming power with permanganates. Keiser (4) has recently made a comparative study of the oxidizability of water as measured by the Kubel-Tiemann method and of the determination of the "chlorine number" of Froboese (3). His results are very interesting and will be referred to later.

[1]Research paper No. 53, Journal Series, University of Arkansas.

Before considering the actual data it is best that some of the principles of each of these tests be taken up. The oxygen-consumed test (1) was run according to Standard Methods, using 10 cc. $KMnO_4$ in an acid solution at the temperature of boiling water for thirty minutes. It was found in connection with this that an interesting relation exists between the amount of oxygen consumed and the amount of permanganate first added to the sample. This is shown in table 1.

Relation of oxygen-consumed value to the amount of $KMnO_4$ used in making the test.

TABLE 1

Oxygen-consumed values, in parts per million, with different amounts of permanganate

Sample	$KMnO_4$ 5 cc.	$KMnO_4$ 10 cc.	$KMnO_4$ 15 cc.	$KMnO_4$ 20 cc.	$KMnO_4$ 25 cc.
Tap water	1.25	1.90	2.03	3.14	5.04
Spring	2.10	3.02	4.76	6.10	6.30
Well	1.06	1.30	1.75	1.96	2.70

We see from this that the law of mass action is responsible for the gradual increase in oxygen-consumed values with additional amounts of permanganate. We conclude that the 10 cc. $KMnO_4$ used in Standard Methods is purely an arbitrary amount.

It may be seen from table 2 that mass action applies to chlorine absorption as well.

What then shall be the arbitrary amount of chlorine introduced in the test? This of course makes the "chlorine number" of Froboese (3) or the "chlorine index" of Pecker (5) uncertain and ill-defined unless we know how much chlorine has been added to obtain such a value. One of the problems, then, is to ascertain what amount of chlorine should be added for such a test.

Wide Series of Tests

In the hope of finding a better correlation between the chlorine absorption test and the oxygen-consumed method, a wide series of tests was run on numerous samples of potable and non-potable waters. As many tests were made on each sample as were thought necessary to determine any factors which might influence either method. Various amounts of initial chlorine (a standard solution of chlorine water) were used in the chlorine absorption test. One, three, five and ten parts per million of free chlorine were generally used on each sample, the amount of chlorine absorbed being dependent upon the amount added, as would be expected. The ten-minute absorption test, which seemed to be the most feasible one to use, was adopted and used throughout. The amount of residual chlorine was determined by both the o-tolidine and starch-iodide methods. It has been shown by Buswell and Boruff (6) that the two tests are equally good in testing for free chlorine. Analyses were run on thirty or more different samples, using the standard method for determining the oxygen-consumed value. The data regarding the two tests have been compiled in table 2.

TABLE 2

A comparison of the results obtained in using the two methods of determining organic content.

Number	Sample	Oxygen Consumed	Chlorine absorbed in ten mi after adding 1.0 p.p.m.	3.0 p.p.m.	5.0 p.p.m.	10.0 p.p.m.
		p.p.m.	*p.p.m.*	*p.p.m.*	*p.p.m.*	*p.p.m.*
1	Tap	1.00	0.10	0.30	0.55	0.95
2	Distilled	1.11	0.12	0.33	0.40	
3	Well	1.15	0.22	0.43	0.47	
4	Spring	1.15	0.31		0.88	1.75
5	Spring	1.15	0.40		2.39	4.21
6	Tap	1.20	0.17			
7	Well	1.20	0.16		0.58	0.86
8	Well	1.30	0.28	0.50	0.60	
9	Well	1.35			0.67	0.92
10	Well	1.36	0.26	0.46	0.75	
11	Well	1.40	0.30	0.45	0.66	
12	Well	1.46	0.27		0.54	0.88
13	Spring	1.47	0.32		0.50	0.92
14	Spring	1.60	0.35		0.80	
15	Well	1.66	0.35	0.70	0.92	
16	Well	1.72	0.53	1.51	1.75	
17	Well	1.74	0.48	1.20	1.54	
18	Spring	1.95			0.35	0.60
19	Spring	2.10	0.61		0.94	1.10
20	Well	2.27		1.54	2.75	3.50
21	Well	2.37	0.46		0.72	0.87
22	Well	2.72	0.50		1.25	1.32
23	Spring	3.02	0.51	0.83	1.00	
24	Well	3.33				0.60
25	Well	3.85				1.54
26	Well	3.85	0.50	1.10	1.33	
27	Well	3.88				0.55
28	Well	4.50	0.59		1.30	2.33
29	Well	4.70	0.53		0.90	1.63
30	Well	4.81	0.51		1.49	1.75
31	Well	5.00	0.80	1.70	2.85	3.94
32	Well	7.10	0.90	1.90	2.95	4.30

Although in a great many instances the two methods are comparable, strict correlation could not be established between them. The amount of chlorine does not increase in proportion to the increase in the oxygen-consumed value. This is graphically shown in figure 1.

This lack of correlation is probably due in most cases to the fact that it would take more chlorine than was added to equal in parts per million the available oxygen present in 10 cc. of the permanganate. It will be noted that the chlorine absorbed values with 5.0 p.p.m. and 10.0 p.p.m. vary a great deal and, although in general the values increase, these increases are not proportional to the amounts of chlorine added. It would

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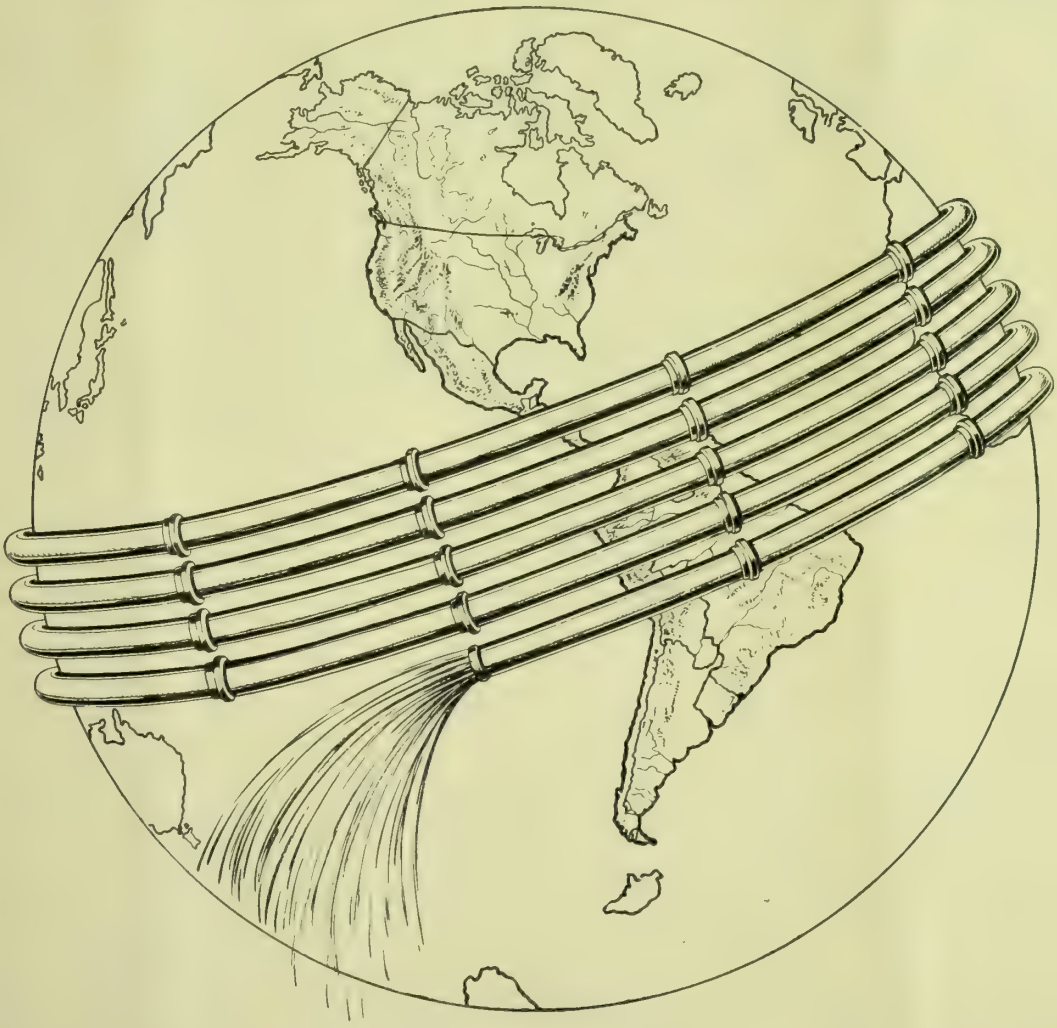

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seem that, if the total organic content of a water is to be determined, even larger amounts of chlorine should be used.

Whether or not the 1.0 p.p.m. value is more indicative of bacterial content than of oxidizable matter is a question. The fact that a water may have a high bacterial count and yet be low in organic content could posibly explain how it may absorb more chlorine in proportion to the amount added with the 1.0 p.p.m. dose than with the 5.0 or 10.0 p.p.m. dose. This happened several times, as seen in table 3.

In studying any other factors to which might be attributed the cause of a wide variation in the results of the two methods, it was noticed that in some cases where the chloride content was exceedingly high the oxygen consumed ran up higher than was expected. On the other

TABLE 3

Oxygen consumed and chlorine absorbed in relation to bacterial count.

Sample	Oxygen Consumed	Chlorine Absorber 1.0	5.0	10.0	Agar Count per cubic Centimeter	Fermentation (Lactose 10 cc.)
	p.p.m.	p.p.m.	p.p.m.	p.p.m.		
Well	1.35	0.21	0.28	0.50	62	Positive
Well	1.40	0.30	0.45	0.66	10	Positive
Spring	1.47	0.32	0.50	0.92	100	Positive
Spring	1.95	0.28	0.35	0.60	400	Positive
Well	4.70	0.52	0.90	1.63	2000	Positive

TABLE 4

Oxygen consumed and chlorine absrobed in relation to alkalinity and to chlorides

Sample	Oxygen	Alkalinity with M. O.	Chlorine Absorber 1.0 p.p.m.	5.0 p.p.m.	10.0 p.p.m.	Chlorides
	p.p.m.				p.p.m.	p.p.m.
Well*	1.35	0.21	0.28	0.50	3.1	Trace
Well*	1.46	0.20	0.44	0.85	4.0	Trace
Spring	1.15	0.40	2.39	4.21	177.0	42.5
Spring	2.10	0.61	0.95	1.10	128.0	12.5
Well	2.27	0.78	2.75	3.50	191.6	51.0
Well	2.72	0.50	1.25	1.32	68.0	10.0
Well	2.37	0.46	0.72	0.87	98.0	228.56
Well	4.50	0.58	1.30	2.30	105.0	102.58
Well	4.70	0.52	0.90	1.63	47.2	256.0

*Low in both alkalinity and chlorides.

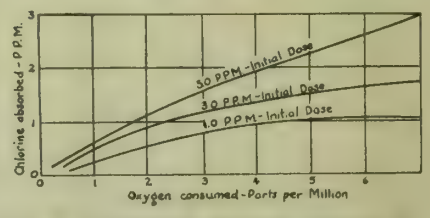


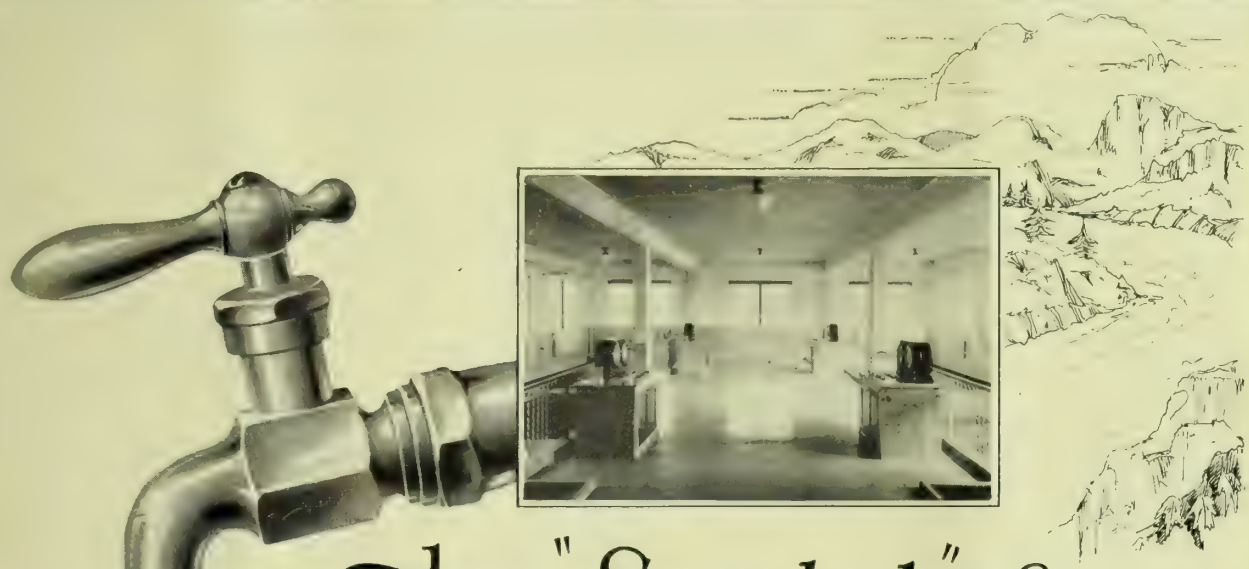
Fig. 1 Comparison Between Chlorine-Absorbed and Oxygen-Consumed Results (Average Values)

hand, some waters high in alkalinity absorbed an unusual amount of chlorine. These facts are shown in table 4.

This might be explained by the fact that more of the available oxygen is used in oxidizing the large amount of chlorides present. A water high in alkalinity might absorb more chlorine in the formation of certain hypochlorites.

In connection with the work which

(*Continued on Page 51*)



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Referring to the illustration it will be seen that the tank contents are circulated through a centrally-located cylindrical draft tube in which a marine propeller is rotated. The draft tube, which revolves slowly, is equipped at its lower end with a pair of radial arms furnished with plow blades.

The tank contents are given a general circulating movement in both the horizontal and vertical planes which results in a high rate of change of position of the various particles in the water being treated. The path of travel may be characterized as first, upward through the draft tube; second, radially outward just below the surface; third, down through the annular space between the draft tube and tank; and fourth, radially inward to the base of the draft tube. It is the function of the slowly revolving rake arms to keep the bottom of the tank free from settled solids at all times and to serve as a means of moving such particles as do settle to a point under the draft tube where the sucking action of the propeller may elevate them to the surface and return them to circulation.

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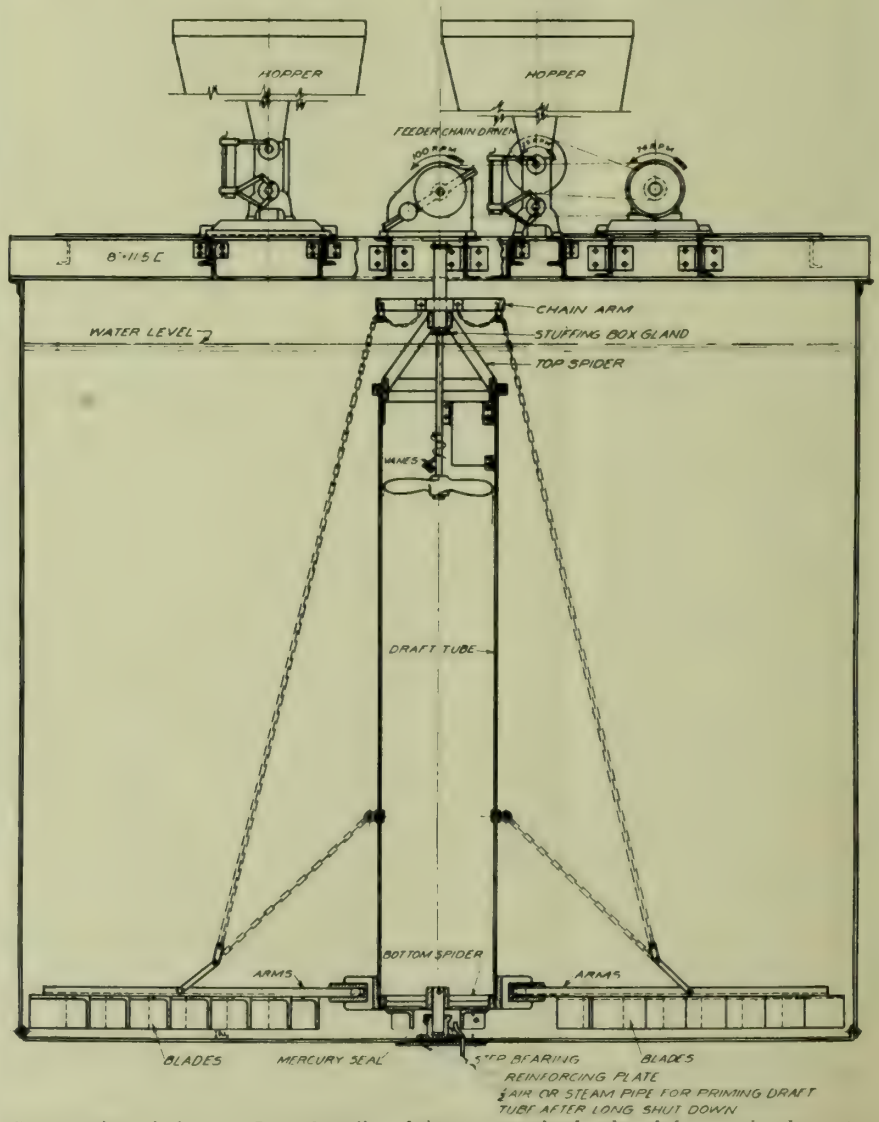

Cross-section of the new Dorr Impeller Agitator recently developed for use in the waterworks industry.

spanning the tank, the solid propeller shaft running within the hollow draft tube shaft. The entire weight of the mechanism is carried by the steel supports, a submerged bearing at the bottom of the tank simply serving as a guide. The propeller is of the standard marine type and is rotated at a relatively high speed compared with the draft tube. The radial arms are hinged to and rotate with the draft tube and are provided with chains so that they may be swung into a vertical position in case they become stalled in the settled solids after a shut down with a full tank. The water to be treated enters through an opening in one side of the tank slightly below the surface and overflows through a similar opening diametrically opposite but at the water level. Mechanical feeders for adding lime, soda ash, ferrous sulfate, alum, etc., may be located conveniently upon the supporting structure.

Turn over, the time required to completely circulate the tank contents, may be varied to suit the particular requirements of each water softening problem and usually ranges from one to eight minutes. The rate of turnover is influenced by the speed, pitch and diameter of the propeller. Accordingly, by varying the diameter of the draft tube and the propeller characteristics, velocity also may be varied to suit the requirements of different types of treatment.

In addition to the water works field this agitator is expected to find a wide application at plants where industrial wastes are treated chemically before sedimentation in mechanical clarifiers. Where exceptionally large volumes of water or waste are handled several agitator mechanisms may be installed in a single large tank.

Leadized Pipe Designed to Combat Corrosion

A New Process of Protective Coating for Pipe Lines Proves Valuable to Waterworks Industry

During the past few years, reports have been received here in the west of a process developed on the east coast, for protecting underground pipes against corrosion. The name of the product produced by this process is Leadized Pipe, and was originated for use in railroad roundhouses, where a sulphuric acid is generated from the sulphur fumes in coal smoke together with air moisture. The effect of these acid fumes upon black or wrought iron pipe is very corrosive. The process proved so valuable in this connection that experiments were conducted with the idea of combating other corrosive agents, particularly those found in soils, bad water, or due to other condi-

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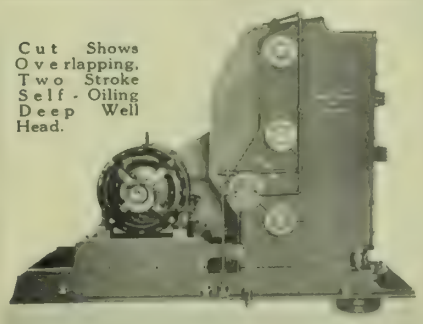

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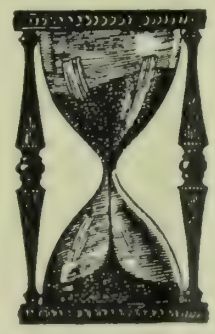

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tion. These experiments proved so successful, that the originators of the process organized the Locomotive Terminal Improvement Company, with offices at 80 E. Jackson Blvd., Chicago, for the purpose of introducing it to the general trade, and the success that they have been attaining is responsible for the reports which have reached this section. A description of the process, as given us, follows:

The coating of steel with lead to protect it not only against oxidation but acid corrosion, is an old art but up to the last few years has never been a successful one. Lead does not like steel and it has always been difficult to get a solid coating of lead free from pin holes or spots.

Leadizing is a trade name for a patented process of a coating with lead or lead alloys. Roughly, after the material has been very thoroughly cleaned in a pickle it is put in a caustic bath. This is a saturated solution and kept at 240 deg. Fah. The tank holding the caustic is connected to one end of a generator and the material to be treated to the other end, and we use a throw over switch. The material first becomes an anode and then a cathode. After treatment in this bath the pipe to be treated is washed with steam and hot water and goes into a plating bath. This is a caustic bath using tin, cadmium and copper salts and a half ampere per square foot of surface of a 6 volt current. The coating is of a lower melting point than lead and when the pipe goes into a molten bath the lead alloys with the preliminary coating and the whole either alloys or knits so firmly to the steel that it becomes a part of the surface. The facts are, while lead does not like steel, the metal in the preliminary coating does, and lead takes kindly to this coating so that the result is a solid coating that is a part of the surface of the steel.

The uses for Leadized Pipe as developed so far are as follows:

All pipe around railroad yards and shops, both underground and above ground.

High pressure water mains where soil conditions corrode plain pipe.

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Importance of Forests to Water Conservation

(Continued from Page 24)

The foregoing analysis of the effects of forests on water conservation has been based entirely upon the physical factors that influence the disposal of precipitation. Do measurements on stream flow bear out the conclusions reached by the study of the physical factors? They do. Many of the stream measurement studies have been absolutely useless for showing anything pertaining to the relation of forests to runoff and seepage. A comparison of the average annual discharge from any stream shows us nothing of value for this purpose because the average annual flow may be made up of many short and sharp floods with intervening low stages. Averages cannot be used. Instead of bringing out the facts they conceal them; nor do extreme stages of rivers, such as excessive floods or aggravated droughts, show anything definite with reference to changes in stream regimen. They are accidents and thus cannot be relied upon.

Some of the most important work on the relation of forests to stream flow is that done by Mr. M. O. Leighton of the U. S. Geological Survey and by the U. S. Forest Service. Leighton's studies show that during the past 20 years or so there has been a marked increase in the fluctuation of all the river stages and in the duration of high and low water of many of the streams in the Uniter States.

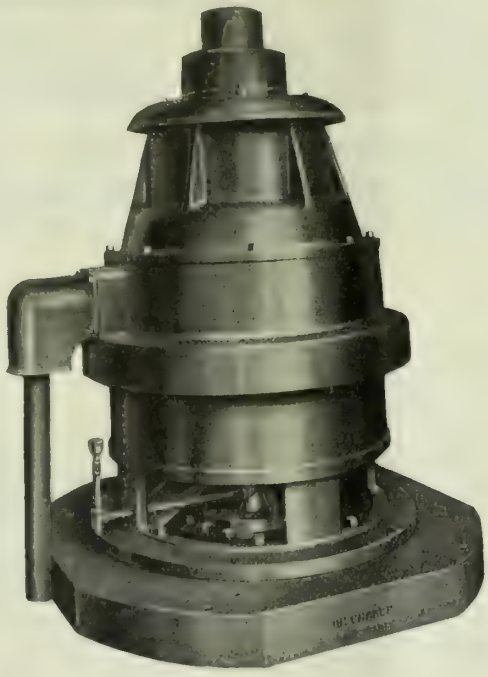
Fluctuation of Stream Flow

In analysing the causes Leighton found that the cutting of the forests on the watersheds of these rivers is responsible for the change in stream regimen. Although a great many examples are available in which the runoff from forest covered and denuded slopes has been compared time will not allow for the presentation of further examples. When scientifically compared these studies show that forests have a very marked effect in increasing seepage at the expense of runoff and thus equalizing the flow in the streams from the forest covered watersheds. Of course, here again the degree of influence which the forest exerts will vary with the differences in the factors that have a bearing on runoff and seepage.

Following is a summary of the conclusions established by the studies upon stream flow.

"(1) The total discharge of large rivers depends upon climate, precipitation, and evaporation. The observed fluctuation in the total amount of water carried by rivers during a long period of years depends upon climatic cycles of wet and dry years.

(Continued on Page 57)



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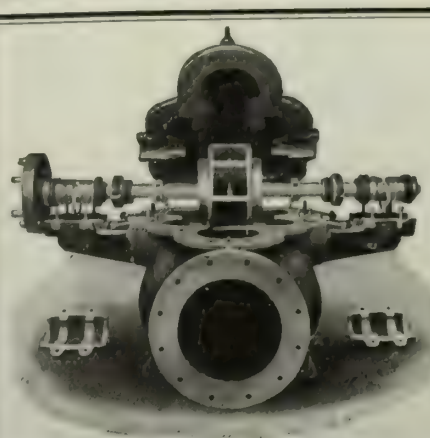

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LEGAL *and* JUDICIAL

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Idaho Court Defines Rights in Use of Drain Ditch

The right to use a drain ditch does not give the user the right to flood adjoining lands.

In the case of Crawford vs. Inglin, 258 Pac. Rep. 541 (Aug. 1, 1927), the Supreme Court of Idaho was considering the rights involved in the construction and use of a drain ditch through certain lands. In limiting the incidental rights arising through its use the Court states:

Evidence merely of permission by land owner to construct a ditch through his field to take up waste water does not sustain a finding that he agreed to, or did, grant lands necessary for the ditch. Any right given plaintiff to construct and maintain a ditch across defendant's land to collect and convey waste water therefrom gave no right to overflow the land. If for any reason the ditch did not carry off all the water, defendant had the right to permit the surplus water to escape from his land, and for such purpose to place a siphon under the ditch. Defendant, though permitting plaintiff to construct a ditch on defendant's land to take up waste water thereon, need not waste any into the ditch, but could use all his water, waste none of it, or apply it to other lands. Plaintiff not pleading or proving right to carry live water through the ditch, it was error to require defendant as a condition to changing location of the ditch to construct it so as to carry live water as well as waste water.

Washington Water District Act Declared Unconstitutional

An act creating a water district must provide for a hearing on the question of inclusion of lands.

In the case of Drum vs. University Place Water District 258 Pac. Rep. 505 (Aug. 9, 1927) the Supreme Court of Washington declares the act to be unconstitutional by reason of its containing no provision for a hearing on the question of lands to be included in the district. It also held that such a corporation was not even a de facto corporation and was subject to attack by residents objecting to the collection of a property tax. On the question of the effect of the finding that the act was unconstitutional, the Supreme Court says:

An unconstitutional act is not a law; it confers no rights; it imposes no duties; it affords no protection; it creates no office; it is, in legal contemplation, as inoperative as though it had never been passed.

In reference to the character of a public corporation of this type, the Court states:

Generally speaking, all public corporations performing any duties within a restricted area are to that extent at least, municipal corporations. (cases cited).

That it was the intention of the Legislature, in enacting our Water District Law, that municipal corporations would be created can hardly be questioned, for Sec. 11583 of the Act provides " . . . And such water districts shall then be and become a municipal corporation of the State of Washington" . . . and they have heretofore been recognized as such by this Court. We think it may fairly be said that the corporation organized under the provisions of this act is, to a limited extent, a municipal corporation. It is, however, organized for but one purpose; to supply the residents of the district with water for domestic uses, a special benefit, as that term is generally used.

Reaffirm Opinion That Bonds Were Legally Issued

Re-hearing granted in the Stowell vs. Rialto Irrigation District case.

In the case of Stowell vs. Rialto Irrigation District (Sept. 26, 1927), 74 Cal., Dec. 361, a rehearing was granted by the California Supreme Court but on such rehearing the same conclusion was reached as on the former hearing (73 Cal., Dec. 118).

The main point involved was whether or not certain bonds had been issued for work done under contract, which contract had been cancelled, or for property purchased. In the former case the bonds would be illegal but if issued for property purchased then there was no question of their legality. The proceedings of the district directors were somewhat irregular in delivering the bonds to a third party to be held until title to certain lands and material was given to the district, but the Supreme Court in upholding the procedure taken, says:

"It may properly be argued that it would have been better if the officers of the District had required the delivery of said deed before the bonds were delivered, as the resolution of the board plainly contemplated, but there was no difficulty in identifying the deed to be received or the bonds to be delivered therefor. The defendant contends that the record shows that the property thereby conveyed was not of the value of said bonds. . . . The record does not show what the value of the property thereby conveyed was to the District. The District may have made a bad bargain. That fact, if it be a fact, would be no defense under the circumstance here shown.

Priority Rights Not Involved in Claim Based Upon Trespass

A trespasser having no title to water in himself cannot complain of its use by others.

In the case of Frost vs. Penfold (Aug. 1, 1927), 258 Pac. Rep. 534, the question arose as to the right of Appellants to certain waters of a spring. The Supreme Court of Idaho in sustaining the action of the trial court, says:

Appellants have wholly failed to show any right in themselves to any of the waters of the spring in controversy or the ditch leading therefrom. The permissive use by appellant of water from the upper ditch flowing from respondents' spring cannot be the basis of a prescriptive right to the use of such waters, since such use is not hostile to the owner. The unauthorized attempt to use respondents' ditch against their will and objection, being contested by the owners of the ditch, is not sufficient to initiate a valid appropriation. . . . The contest was not between water users as to priorities, but between trespassers and the owners in regard to the enjoyment of a ditch and the waters flowing therein.

Court Decision Affects Frog Tanks Reservoirs

(Continued from Page 23)

and also from lands adjacent thereto and on either side of the river. The amounts of the waters pumped from these underground sources were of great quantities, as was proved by the plaintiff, and admitted by the defendant.

The defendant's expert witnesses gave it as their opinion that the Hassayampa river in ancient times had passed southeast between the White Tanks Mountains and the Hieroglyphics, joining the Gila to the eastward of the White Tanks instead of the west as at the present time, and that there is at present an underground contribution of water from that stream to the water body underlying the Agua Fria and western portion of the Salt River Valleys. The court stated that if such were the case, the banks of such underground stream would be the hill wash on the northern side of the White Tanks and that on the south side of the Hieroglyphics. "Whatever such contribution might be, however, could not affect plaintiff right of appropriation, as such waters would only be tributary to the underground flow of the Agua Fria."

The defendant endeavored to show that the water that was being pumped from the wells of the plaintiff did not originate from the Agua Fria River, and that it was not a definite underground stream, but that it consisted of a bed of diffused percolating water, and that it was impossible to locate its source, or any confining beds, banks, or underground channel; and further that the underlying strata adjacent to the Agua Fria River consisted of a heterogeneous mass of detritous material not necessarily deposited in a manner that would indicate that an underground channel or channels existed.

In integrating the material presented at the hearing the court stated: In concluding this subject it seems to me that the language used by the Supreme Court of California in the case of Miller vs. Bay Cities Water Company, 107 Pacific 115, in describing the conditions found to exist in the Santa Clara Valley may with equal force be applied to the situation here. Altering the language merely to the extent of substituting names of the locality and streams under consideration here in place of those to which the decision in that case had reference, it would read as follows:

"There can be no doubt that it was as clearly proven under the evidence as such matters can be proven that there are underlying a vast territory in the Agua Fria valley—some twenty miles square—numerous channels created by the Agua Fria River through its action in ages past when, in the building up and forming of the valley, its waters rushed in enormous quantities from the mountains, changing from one side of the valley to the other, and constantly varying its course in its flow southward toward the Gila River. These old channels now lie beneath the surface of the valley at varying depths; channels beside channels, and channels crossing and interconnecting each other, through each of which the Agua Fria River once flowed in its open course, but which are now underground channels filled with loose and coarse gravel, through which waters still flow, supplied to them through percolation from the Agua Fria River, with which these old gravel channels have always been connected, and that the particular underground channel or gravel stratum from which the wells of the plaintiffs are supplied constitutes one of those old channels, which is likewise connected with and supplied from the waters of the Agua Fria River."

It was the further decision of the court that the plaintiff has acquired a right to subsurface waters to the amount of seventy second feet continuous flow and that the defendant was obligated to allow sufficient water to pass the Frog Tanks dam so that the plaintiff would be able to pump from its wells the above named amount. In connection with this

(Continued on Page 57)

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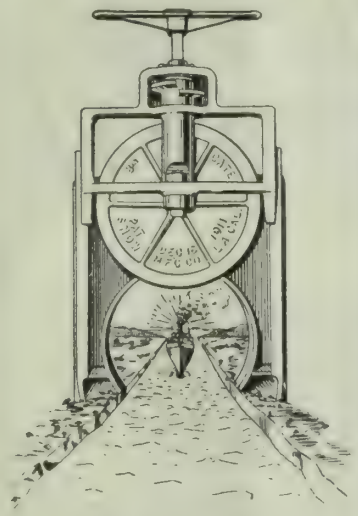

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LOS ANGELES

A Thew Shovel at work—a second machine may be seen at the right of the picture.

Thew Shovel Company Builds New Type of Pull Shovel

A new type of pull shovel or trench hoe has been put on the market by the Thew Shovel Company, which offers some unusual advantages for sewer and excavating work. It is called a Back Digger by the Thew Company because it is more than a trench machine, being very efficient in cellar work and other kinds of digging as well.

The primary difference between this and previous types, is in the control of the dipper, which can be tilted by the operator to any angle desired, at any stage of the digging or dumping operation, and held in position or changed by the operator at will.

Instead of spilling the dipper load through the entire arc of the digging arm as with the stationary dipper type, this tilting dipper permits the operator to hold his load until he has spotted his dipper exactly where wanted, over a wagon, truck or spoil pile, after which the dipper can be instantly dumped. When dumping close, much time is saved because it is unnecessary to swing the dipper to the extreme limit each time to completely empty it. When sticky material clings to the dipper the operator can shake the dipper to dislodge positively and completely all the unspilled remainder.

The control of the dipper tooth angle at any position of the digging arm also provides digging advantages not possible with the stationary type of dipper. In basement digging it permits trimming the sides and bottom of the excavation or making a straight vertical cut at the start of a trench or at the finish.

The tilting dipper is also a great aid in back filling. The dipper can be pulled to the edge of the trench in a horizontal position pushing the dirt before it and can then be tilted to empty the dipper into the trench. The ability to hold dipper in any position wanted while back filling, permits cleaning up the entire spoil pile without gouging into the solid ground beneath it.

This equipment can be attached to any Lorain-75 or Lorain-60 shovel now in the field. The change can be made very easily and quickly.

Standard Oil Installs Deep Well Pumps at Refinery

Feature of Water Lubrication Causes Oil Company to Select Particular Type for Pure Water Supply

Adoption of water lubrication in place of oil constitutes a feature of a large capacity water pump installed in the Standard Oil Company refinery at Baton Rouge. It is one of the first pumps of its type to be chosen by an oil operating company, although hundreds of water lubricated pumps are said to be in operation in the irrigation fields of the Pacific Southwest.

The pump is a stock design, manufactured by the Pomona Manufacturing Company at Pomona, Calif. This pump is producing 1300 gallons of water per minute against a total head of 327 feet,

For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

200 feet of which is below the surface. The water is produced from a 12-inch well, being pumped with a set of 5-stage 16-inch turbines which draw the water up through the column to the pump head where a 10-stage 12-inch turbine booster unit is connected to boost the water to the surface. The booster, being an integral part of the pump, makes unnecessary the use of an auxiliary pumping unit.

Water Lubrication

In most types of centrifugal turbine pumps oil is transmitted by one means or another to the lower bearings that support the runners within the bowls. In Pomona Pumps such as the one installed for the Standard Oil Company, oil is dispensed with entirely under the pump head and that which is ever present in the well, water, is used as the lubricating element. By using water for lubrication, any sand that intrudes is washed out by the water and vibration within the bowls is also greatly minimized, according to the manufacturers.

One of the reasons for selecting this type of pump, according to an official, was the fact that a purer water supply was available through the elimination of any oil below the surface. There being no oil, nothing can contaminate the water, which is an important factor where the supply is used for refining purposes, it is stated. A large number of municipalities, laundries, technical plants and others relying upon the cleanliness of the water supply have adopted pumps using water lubrication in service.

Surface Adjustment

Provision is made for adjustment of both turbine units on the surface of the ground. The pump head is equipped with an underground discharge and has a Kingsbury plate bearing in the head. The pump head proper is operated by a 200 H. P. Westinghouse Standard vertical electric motor, 2200 volts, 3 phase, 60 cycles. It produces the water at 1160 revolutions per minute.

An interesting phase of this order was the fact that the completion of preliminary tests is said to have so impressed engineers of the Standard Oil Company that they placed an order for an additional pumping unit to be of 1500-gallon capacity. It likewise will embody the water lubrication principle.

The Menge Pump & Machinery Company of New Orleans handled the installation for the California pump concern. The entire pump outfit was constructed at the manufacturers' plant at Pomona, California.

F. T. Crowe, former general superintendent of construction, was a recent visitor at Minidoka Dam, Minidoka project, Idaho.

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Water Rights of San Gabriel River Still Contested

(*Continued from Page 22*)

protecting their existing and future supplies. The applications in their order of priority are as follows:

No.	Appliance	Nature
3328	City of Pasadena	For storage
3329	City of Pasadena	For storage
3330	City of Pasadena	For storage
3331	City of Pasadena	For storage
3741	City of Pasadena	For storage
4014	Rubio Canyon Land and Water Ass'n and Los Flores Water Company.	For storage and direct diversion
4049	City of Monrovia	For storage and direct diversion
4447	City of Pasadena	For direct diversion
4448	City of Pasadena	For storage
4534	City of Alhambra	For direct diversion
4582	Glendora Consolidated Mutual Irrigating Company	For direct diversion
4590	City of Long Beach	For storage and direct diversion
4604	City of Whittier	For storage and direct diversion
4860	City of Compton	For storage and direct diversion
5290	City of Alhambra	For direct diversion

The investigation had for its objects the gathering of facts concerning water supply, ground water movements, present use of water, future demands, and other data necessary for the Division of Water Rights to take action on the applications before it. It also had for an object the compiling of all data necessary to make possible the maximum conservation of the water resources of the San Gabriel Basin. The Bulletin lists rainfall data, well measurements, stream measurements, run-off data, percolation data, etc. It confines itself to facts and to only such analysis as is necessary to make the facts intelligible.

From an analysis of run-off data and percolation measurements on the San Gabriel River during 1926 a curve is drawn which gives the percentage of the flow at the mouth of the canyon which percolates into the ground-water basins. This curve shows that of a flow of 625 second-feet at the mouth, 100 per cent would percolate while of a flow of 2000 second-feet 70 per cent would percolate and of 10,000 second-feet 47 per cent would percolate. The memorandum contains a statement that it is believed that any calculation of waste from San Gabriel Canyon into the ocean based on this curve must be increased 20 per cent to get a true estimate. Using this curve and percentage increase, computations are made to show the waste into the ocean and the results set forth in a table. This table shows that for the period 1904-05 to 1925-26 the average annual waste into the ocean was 60,860 acre-feet. This is 55 per cent of the water passing the mouth of the canyon. In three years of the 22 there was no waste and in four additional it was not more than 10,000 acre-feet. Additional data gathered since these computations were made indicate that the waste found is too small.

Return Flow Waters Puzzle to Water Masters

(*Continued from Page 17*)

department is taking the position that unless water users quitclaim their rights to prospective return flow from projects to be constructed, or extensions of old projects, new projects will not be constructed. There are undoubtedly many other instances along the lines cited which have not come to the attention of the writer.

Importance of Problem

The importance of this return flow problem may be realized when mention is made of the fact that generally 50 percent of canal headgate diversions is a potentiaal source of return flow. The following instances of volume of return flow are cited to show the large factor return flow plays in river supplies:

On the North Platte River in Nebraska in a river section of 80 miles length between the Wyoming-Nebraska line and Bridgeport the present annual return flow, a large part of which is from drains, amounts to 600,000 acre-feet. On the South Platte River in Colorado the return flow from Denver to Julesburg, a distance of 210 miles by river channel, amounts, in round figures, to 1,500 second-feet continuous flow. Drainage recovery from 350 miles of drains on the Rio Grande Project in New Mexico and Texas, totals over 300,000 acre-feet per year.

Generally speaking return flow from up-river development supplies downstream prior rights, and thereby automatically releases up-river direct flow for up-river projects or for new devlopment. When this fact is clearly realized and the legal concept understood, that water users do not acquire a property right in water, there can be little excuse for new legislative or court formulae concerning ownership of return flow.

Private ownership could not be retroactive. If it were, it would upset water rights and property values of immense magnitude on all river systems of the irrigated west. Private ownership of return flow, if ever accomplished in the future, would give a preferential

status to all projects or water users who would participate as beneficiaries and hang a correspondingly heavy burden on new development. Such a doctrine is opposed to public interest, public ownership and public control of western rivers. State engineers, water officials and water users should combat and intervene in such efforts, and see that a foothold is not secured which might later be expanded into a water curse, compelling new irrigation development to stand, not only the construction cost of a system, but also to pay tribute for its water supply.

BIBLIOGRAHPY ON OWNERSHIP OF RETURN FLOW

OWNERSHIP AND DISPOSAL OF SEEPAGE WATER.

J. G. Whitehead, Banker, Mitchell, Nebraska.
Proceedings Nebraska State Irrigation Association, pp 217-220, 1920.
(Advocates private ownership of Return Flow.)

DISPOSAL OF DRAINAGE YIELDS, NORTH PLATTE RIVER AND PLATTE VALLEYS.

Andrew Weiss, Engineer, U. S. R. S., Mitchell, Nebraska
Proceedings Nebraska State Irrigation Association, pp 40-51, Dec., 1921.
(Advocates private ownership of Return Flow.)

PROPERTY RIGHTS IN SEEPAGE

R. O. Canaday, Attorney, Bridgeport, Nebraska.
Proceedings Nebraska State Irrigation Association, pp 157-167, Dec., 1926.
(Opposes private ownership of Return Flow.)

RETURN FLOW AND ITS PROBLEMS ON RECLAMATION PROJECTS

E. B. Debler, Engineer, U. S. B. R., Denver, Colorado.
New Reclamation Era. pp 124-125 Aug., 1927.
(Advocates private ownership of Return Flow.)

NEW LEGAL PROBLEMS

Biennial Report of the Division of Water Rights, State of California, pp 20, Nov. 1, 1926.
(Seeking for a legal principle to apply on Return Waters.)

Chlorination of Various Types of Waters

(Continued from Page 40)

has been done, many data of interest have been gathered from Keiser's paper (4) in which he makes a comparative study of the two methods on raw Elbe water and the filtered water at Hamburg. Keiser's work was found in the literature after the investigation here had begun. His data might explain some of the variations observed here in comparing the two tests. A study of these results shows that, for the determination of organic matter in water free from albuminous products, the permanganate process according to Kubel and the determination of the chlorine number of Froboese are equally good; on the other hand the content of organic matter in water which has been polluted with sewage, can be exactly fixed only by means of the chlorine absorption test.

TABLE 5

Effect of urine content on oxygen consumed and on chlorine absorbed

Urine Content	Oxygen Consumed	Chlorine Absorbed (10.0 p.p.m. Added)
mgm. per liter	*p.p.m.*	*p.p.m.*
Tap Water	1.30	0.32
1	1.35	0.40
3	1.38	0.72
5	1.33	0.80
10	1.36	0.85
50	1.42	1.15
100	1.45	1.59
250	1.96	2.51

In confirmation of Keiser's work, the data indicated in table 5 show the results carried out here with increasing amounts of urine in tap water. The chlorine- absorbed and exygen-consumed values were noted.

It is indicated here that albuminous products like urine are not readily attacked by permanganate, so it would seem that the determination of the oxygen-consumed value is inaccurate under such conditions.

Summary

According to all the data shown herein, the correlation between the two methods is good as long as no albuminous material is present. In the latter case the chlorine absorption test is the only safe criterion. In view of these facts the chlorine absorption method should be in all cases an equally desirable one to use and, in certain cases, it certainly would be preferable. It seems entirely reasonable that a standard method of procedure should be established wherein the quicker ten-minute chlorine absorption test would be used as a substitute for, or at least a companion test with, the slower permanganate method of determining oxygen consumed.

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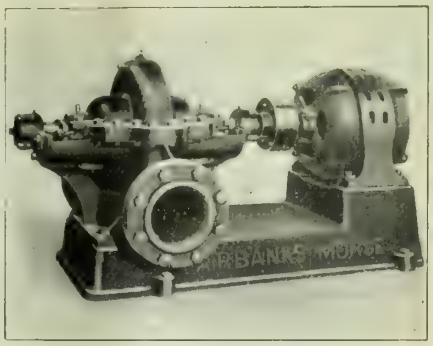
(1) Standard Methods of Water Analysis, 6th edition, p. 22-24 (1925).
(2) Wolman, Abel, and Enslow, L. H.: Jour. Ind. and Eng. Chem., 11, p. 211 (1919).
(3) Froboese, Victor: Arb. Reichsgesundheitsamte, 52, p. 211-22 (1920).
(4) Keiser, Karl: Gas und Wasserfach, 69, p. 65-69 (1926).
(5) Pecker, H.: Jour. Pharm. Chim., 18, p. 134-9, 167-77 (1918).
(6) Buswell, A. M., and Boruff, C. S.: Jour. Amer. W. W. Assn., 14, p. 384-405 (1925).

E. K. Humphrey, of the Oregon State engineer's office, spent two days on the Klamath project during October, conducting tests of the pumping plants of the Malin and Shasta View irrigation districts.



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SURVEY *of* HYDRAULIC DEVELOPMENT

A summary outline of developments contemplated on Western projects which have been announced during the month

Irrigation Development

HEMET, CALIF.—Riverside county supervisors have authorized the formation of the Hemet Irrigation district.

MODESTO, CALIF.—D. W. Murphy, consulting engineer, Los Angeles, has been called to Modesto by the Modesto Irrigation District, to plan a comprehensive drainage program for the district. His report is to be made to the directors within a few days.

VISALIA, CALIF.—An election will be held Nov. 5 to vote on the formation of the Kaweah Delta Water Conservation District in the Kaweah River delta. Of the total, approximately 346,520 acres, 259,360 acres are in the Tulare county and 87,160 in Kings County.

MESA, ARIZ.—Roosevelt Water Conservation district will handle by day labor the work of lining canals, involving 3,500,000 sq. ft. of Gunite. Materials have been purchased and equipment rented. Riverside Portland Cement Co. was awarded contract for furnishing 30,000 bbls. of cement.

MODESTO, CALIF.—Modesto and Turlock irrigation district and the Yosemite Power Co. applications covering the Goveland water storage and power projects on the Tuolumne river will be heard at a sitting of the Federal power commission in San Francisco on October 6th.

SALT LAKE CITY, UTAH—Preliminary plans for the irrigation of some 40,000 acres in the Huntington River district are now under way, according to reports. This work is under the direction of the state engineer, and E. O. Larsen engineer in charge of the Salt Lake basin project.

SAN DOMINGO, LOWER CALIF.—Government engineers have completed a survey of the San Domingo Watershed in Lower California. Plans are reported to be under way for the construction of dam to create a reservoir with a capacity to irrigate 50,000 acres. The land is located 225 miles south of San Diego.

YAKIMA, WASH.—Plans for additional irrigation of the Wapato district have been approved, which means the installation of a pumping plant which will handle water for the additional 10,500 acres that are about to be developed. This project contemplates the use of over 700 horsepower in the pumping installation.

ELLENSBURG, WASHINGTON — U. S. Reclamation Service, Ellensburg, will call for bids within the near future for the construc- of Division of the north branch canal, Kittitas Division of the Yakima project, Ellensburg, Washington. Separate bids are to be asked on the following schedule: Schedule 1, construction of 5½ miles of canal from the siphon outlet to Dry Creek. Schedule 2, construction of 5½ miles of canal from Dry Creek to Jones Creek. Schedule 3, construction of 5000 lin. ft. of 12-ft. diameter tunnels, three tunnels between the Yakima River Siphon and Dry Creek. Schedule 4, construction of four siphons as follows: Hayward canyon siphon to be 525 ft. long, 11-ft. 2-in. diameter; Sheep Dip Canyon siphon, 486 ft. long; Dry Creek siphon, 1546 ft. long; and the Little Dry Creek siphon, 386 ft. long. Above work involves the following approximate quantities: 760,000 cu. yd. canal and structure excavation; 5000 lin. ft. tunnel; 55,000 cu. yd. backfill; 8500 cu. yd. puddling; 20,000 cu. yd. concrete; 1,670,000 lb. reinforcing steel, placing only; 57,000 lb. structural steel; 117,000 ft. B. M. lumber (bridges and structures); 560,000 B. H. lumber (tunnels); 22,500 ft 8-in. drain pipe; 250 ft. 18-in. to 36-in. concrete pipe.

OAKDALE, CALIF.—The Oakdale Irrigation District has authorized an expenditure of $100,000 for the purpose of widening canals, so that a larger area can be irrigated. The Modesto Irrigation District also plans to expend $207,000 on improvement and extensions to the present system. The Merced Irrigation District plans an expenditure of $348,000 on improving and enlarging the present canal system, installing new drainage equipment and pumping apparatus.

PATTERSON, CALIF.—State Bond Certification Commission has approved bonds of the West Stanislaus Irrigation District, Patterson, Stanislaus county, recently voted in amount of $1,216,376 for improvements, of which $854,265 is to be used for construction of: pumps 45 cu. sec. capacity, 32 units to cost $88,000; motors and automatic control. 32 150-hp. motors, $81,920; main canal, inv. 191,000 cu. yd. earth excavation, $58,500; 7 buildings for pumps, etc., $100,000; unlined main later., 155,000 ft., $31,000: concrete lined main laterals, $265,000; sub-laterals, $10,300; concrete lining, main canal, $90,900; transmission lines, copper, $2933; poles and insulators, $4067; outdoor disconnects, $3000; pump station transformers, $25,000; sub-station transformers, $32,500; lighting arresters, $570; incoming line panels, $1600. W. F. Woolley, Patterson, is Chief Engineer of the District.

SAN YSIDRO, CALIF.—The San Ysidro irrigation district has started an extensive improvement program which will include the installation of a new pumping plant, change in the reservoir site and laying of water mains. Some time ago the board of directors called for bids for the sinking of six wells, erection of a pit and pumphouse and 6-in. suction pipes. They received three bids on this work, the contract going to the lowest bidder. Michel Hatherly, for $7900. The irrigation district recently purchased 15 acres of land adjoining the present irrigation district's site in the valley, on which site the new wells will be drilled. Mr. Hatherly has his equipment on the ground and work will start immediately. A change in the reservoir site will also be made as soon as the old reservoir is dismantled, the upper reservoir on the north side of town will be used. It is 50 ft. higher and has a capacity of 300,000 gallons. The project will entail the laying of 10,060 ft. of 10-in. casing to the new site, which will be laid on Cottonwood Ave. Consumers in the district met at the irrigation district office October 17 and by a unanimous vote adopted these improvements as outlined by the board of directors.

Reservoirs and Dams

SANTA BARBARA, CALIF.—It has been estimated that the Sheffield reservoir can be reconstructed for $150,000 instead of $350,000 as orginally estimated.

SANTA FE, N. M.—A site for a reservoir costing in excess of $100,000 and for which funds were appropriated at the last legislature, is being staked out at Talpa in the Talpa valley by Ed Healy of the state engineer's office.

MARTINEZ, CALIF.—The water development project outlined in the last issue of HYDRAULIC ENGINEERING is now about to become a reality. This project contemplates a large storage reservoir in Conn Valley Napa County, and a 40 inch line to Martinez and other cities.

SAN DIEGO, CALIF.—Application has been made by the city of San Diego for permission to construct an outfall sewer pipe line extending into the Pacific Ocean 1400 feet from mean high tide line at Loring St., Pacific Beach, San Diego, Calif. Maps showing location of the proposed structure will be on exhibition in the office of the U. S. Engineer, 725 Central Bldg., Los Angeles, until 11 a. m., Saturday, Oct. 22. C. P. Gross, Major Corps of Engineers, District Engineer.

COOLIDGE DAM, SAN CARLOS, ARIZ.—James G. Tripp, formerly with the Carl Pleasant Co., in charge of the Frog Tanks Dam construction, has been appointed superintendent of construction on the Coolidge Dam by Atkinson, Kier Bros., and Spicer Co., the contracting company which is building the Coolidge Dam project. Mr. Tripp had charge of the Little Rock Dam construction from 1922 to 1924 for Bent Bros.

SEATTLE, WASH.—Hugh L. Cooper of New York City has filed application with the state supervisors of hydraulics for a permit to appropriate 8500 second feet from Clarks fork of the Columbia River for the purpose of power development. The plans filed with the application call for a 425 foot high concrete arch dam, with a crest 350 feet long, having an available power head of 245 feet. The estimated cost of the entire development is $17,600,000.

SEATTLE, WASH. — Winston Brothers Co., Minneapolis, has been awarded contract by the board of public works at approximately $2,500,000 for the construction of the

Holmes-Manly Cracking Plant of the California Petroleum Corporation recently completed at Watson, California.

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Diablo Dam, on the Skagit River, in Whatcom county, Washington. The structure will be a concrete arched dam, and will involve placing about 220,000 cu. yds. concr. in the body of the dam and other appurtenant work.

SANTA BARBARA, CALIF.—Louis C. Hill, consulting engineer, Hollingsworth Bldg., Los Angeles, has estimated cost of reconstructing the Sheffield Reservoir, increasing the capacity from 10,000,000 gals. to 50,000,000 gals. at $175,000. If lining is omitted the cost can be cut to $100,000. Construction without the lining is not recommended by the water superintendent, Victor Trace.

SAN DIEGO, CALIF.—The city council has accepted the report of Louis C. Hill, consulting engr., Hollingsworth Bldg., Los Angeles, advising against the construction of a dam at the present Sutherland site and stating that a safe dam could be built at the upper Sutherland site, known as site No. 1. The council has ordered the contractors, Edwards, Wildey & Dixon, of Los Angeles, to move the construction plant to the new site. Mr. Hill states that while the upper site is not ideal, it is safe for the construction of a multiple arch dam. J. W. Williams, the city's hydraulic engineer, will prepare an estimate of the cost of the proposed dam. This estimate will be presented to the council in 30 days. Legal details of the contract between the city and the contractors will probably be settled within a few days.

HELENA, CALIF.—Permit has been granted by state department of public work, division of water rights, to C. S. Freeman, 4259 S. Normandie Ave., Los Angeles; P. W. Porter, 525 42nd St., Sacramento; J. H. Knapp, Helena; and R. V. Pearsall, Long Beach, and partial assignment to the California Trust Co., 629 S. Spring St., Los Angeles, for the appropriation of 350 cu. ft. per second from the north fork and 50 cu. ft. per second water from the east fork of the north fork of the Trinity River in Trinity county, for generation of power. Project is located near Helena, Trinity county. Proj. construction of 15 miles of conduit lines, rock fill dam to be 320 ft. high, 1400 ft. long on top, 75 ft. long on bottom and 20-ft. wide on top, earth fill dam with puddled core and rip-rap facings, 180-ft. high, 670 ft. long on top, 75-ft. long on bottom, 20-ft. wide on top. Three power plans to develop 71,773 h. p. as follows: (1) total fall 340 ft. to develop 13,523 h. p.; (2) total fall of 1368 ft. to develop 54,409 h. p.; and (3) total fall of 676 ft. to develop 3841 h. p. Maximum amount of water through the penstocks is 350 cu. ft. per second. Total estimated cost of project is $15,720,000. Actual construction work to start about Dec. 1.

Sewage Disposal

SAN LUIS OBISPO, CALIF.—Plans have been ordered for sewer extension to be put in by the city under the $25,000 bond issue authorized last April.

LEMOORE, CALIF.—County supervisors have approved the formation of a sewer district for an outfall sewer and collection system. Estimated cost, between $50,000 and $60,000.

OXNARD, CALIF.—Recommendations by the city engineer that about $7000 be expended on sewer extensions into the new subdivision, Ramona and Colonia, are now in the hands of the city council.

MONTECITO, CALIF.—Petitions for a sewer system in the Montecito District are in circulation, following a conference between property owners and Dr. A. C. Crandall, representing the county, and Engineers Gillespie & Goudy, representing the state.

SANTA BARBARA, CALIF. — Hearing will be held before county supervisors Nov. 7 on the proposed $500,000 sewer system for Montecito. Carl Wyant, superintendent of the Montecito Water District, is the engineer. An election will probably be called.

LONG BEACH, CALIF. — Arthur H. Adams, city engineer, has recommended that the city authorize proceedings for the construction of a storm drain system to serve the Hill and Atlantic Ave. section, the 25th and Elm Ave. district, and West Hill St. His estimate of the cost is $220,000 to $243,000.

LOS ANGELES, CALIF.—Resolution of intention adopted by the county for sewers in Oaks Ave. between Willowbrook and Paulsen Aves. and portions of Paulsen Ave., Oaks Ave., Peach St., Burlington Ave. and other streets: 8-in. to 10-in. D. & W. S. vitrified pipe sewers, 6-in. hse. sewers, handholes flush tanks, etc.; C. I. No 611 Hearing, Nov. 7.

SAN DIEGO, CALIF.—Edwards, Wildey & Dixon, Los Angeles contractors who have the contract to build the Sutherland Dam, have started excavating at the new site. The first work is on the spillway which is to be 175 ft. wide and is located east of the dam proper. J. W. Williams is engineer in charge for the city. It is hoped to have the foundation abutments poured before the rains start.

SAN BERNARDINO, CALIF. — City council at regular meeting October 17 approved a bond election for $650,000 to provide funds for the proposed sewage collection and disposal system for which Currie Engineering Co. has been preparing plans. Chas. E. Johnson, former city engineer, is handling the project for the Currie Engineering Co. The report of the engineer recommended the installation of a treatment plant to cost $305,000, a site $26,000, and an outfall syphon system leading from the city to a sewer farm $242,000, and the installation of a deep sewer line through the business and principal residential districts of the city.

Waterworks

SIERRA MADRE, CALIF.—Plans are being considered for the purpose of voting additional bonds for the extension of the municipal water system.

HARBOR CITY, CALIF.—Petitions are in circulation for the organization of a water district and for the purpose of voting bonds to the amount of $240,000 for the purpose of bringing an additional supply of water into the community.

PORT ORCHARD, WASH.—Plans have been made for the installation of a new steel water storage tank on the top of the hill at the site of the present tanks. It is probable that bids will be called for upon the installation in the near future.

BELLINGHAM,, WASH.—A special committee has been named by the city council which will act in an advisory capacity on all water problems of the city. The city has recently voted $250,000 in bonds for the purpose of installing a new water system.

For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

VENTURA, CALIF.—Until 11 a.m. Nov. 1, bids will be received by county for constructing four reinforced concrete check dams on Jepson Wash Storm Ditch, Contract No. 501, involving 140 cu. yds. earthwork excavation, 74 cu, yds. A concr. 2400 lbs. reinf. steel, 16 ft. 24-in. corr. iron pipe. Plans may be obtained from the office of the county surveyor, Chas. W. Petit. Certified check, 10%. L. E. Hallowell, clerk.

CULVER CITY, CALIF.—City council will hold hearing Nov. 21 on the matter of authorizing an election in the district known as Municipal Inmprovement District No. 4, Overland Ave., Washington Blvd., Venice short line, north city limits, involving mains, sewers, laterals, structures, cast iron pressure lines, ejector pumping plants, machinery, apparatus, manholes, flushtanks, etc: estimated cost, $364,137.70. Total of proposed issue $400,000. Nelle Brown Haus, city clerk.

BLOOMINGTON, CALIF.—J. F. Davidson, Riverside, has prepared for the citizens' committee on the municipal water system in Bloomington an estimate of the cost of the proposed project. The total is $111,951, as follows:

Pipe lines, $71,451.50.
Fittings, $7500.
Well, 500 ft. at $12 ft., $6000.
Pumps and motor, $5000.
Building, $1000.
Reservoir, $10,000.
Contingent fund, $5000.
Engineer's fee, $6000.

The system will require 6600 ft. 10-in., 22,400 ft. 6-in., and 110,880 ft. 4-in. pipe.

Unit Bids

ABERDEEN, WASH.—A contract for the construction of the three mile tunnel for the lower Wynooche industrial water system has been awarded to Siems, Carlson Company of Spokane, on a bid of $545,626.

SALT LAKE CITY, UTAH— A. Guthrie & Co., Sherlock Bldg., Portland, submitted low bid to U. S. Reclamation Service at Salt Lake Oct. 25, at $1,125,097 for the construction of an earth fill dam, known as the Echo Dam, near Echo, Utah, on the Park City branch of the Union Pacific Ry., Weber River district, Salt Lake Basin Project. Other bids: Utah Constr. Co., $1,131,350; H. W. Rohl, $1,198,953; Jasper-Stacy Co., $1,230,320: Peterson, Shirley & Gunther, $1,371,841; Morrison-Knudsen Co., Boise, $1,377,482; D. A. Foley & Co., $1,396,643; Kaiser Paving Co., $1,496,925; W. A. Bechtel Co., $1,532,-177. Approximate quantities: diversion and care of river, lump sum; 10 acres clear and grub; 40,000 yd. strip for embank; plow dam foundation; 8000 yd. excav., tunnel; 300 yd. excav. cutoff; 1000 yd. excav. open trench; 300 yd. excav. rock trench; 50,000 yd. rock exc. spillway: 5000 yd. embankment, downs; 1,350,000 yd. embankment, clay, sand and gravel; 140,000 yd. embankment, gravel and cobblestone downstream; 50,000 yd. embankment, riprap on upstream face; 50,000 yd. embankment, clay; 2500 yd. backll, spillway; 600 yd. clay pudd. backfill: 3200 yd. high embankment, earth and grav; 2000 yd. high embankment, rolled earth; 16,000 yd. high embankment rockfill; 1000 yd. high embankment rockfill; 1000 ft. drill grout holes: 100 pipes in grout holes; 500 cu. ft. pressure grouting; 800 ft. drill holes for rods; 400 ft. place wood V drains; 60 ft. place 6-in. black pipe; 200 ft. lay 4-in. drain tile; 1200 ft. lay 6-in. sewer pipe; 600 ft. lay 8-in. drain tile; 1400 ft. lay 12-in. drain tile; 112 ft. lay 18-in. sewer pipe; 175 yd. place gravel, spillway; 900 yd. concr. cutoff, open cut; 400 cu. yd. concr. cutoff, open tr; 300 yd. concr. stoped excav; 1700 yd. concr. tunnel lining; 70 yd. shaft lining; 600 yds. concr. gate struct; 160 yd. concr. trashrack; 1800 yd. concr. spillway; 1200 yd. concr. spillway chan; 300 yd. concr. needle valve; construct. needle-valve house; constr. remote contr. house; 725 yd. concr, parapet wall.

SAN DIEGO, CALIF.—J. W. Williams, engineer in charge of the water department, has fixed the cost of constructing a dam at Site No. 1, Sutherland Dam Site, at $2,059,-125. The cost is distributed as follows: $1,341,020 for dam proper; $334,070 spillway and gates; $30,000 outlet works; $10,000 sluicing works; 15% for contingencies, 5% for engineering. The proposed dam would be 160 ft. high and 1250 ft, long. This dam is to be constructed at a site approved by Louis Hill, consulting engineer of Los Angeles, and J. W. Williams, San Diego engineer. No action has been taken by the council.

LOS ANGELES, CALIF.—Llewellyn Iron Works, N. Main and Redondo, submitted low bid to county October 10, ,at $5238 for radial gates for Puddingstone Diversion Dam, involving (1) 4 radial gates, 15 ft. wide by 13 ft. high at $4303, (2) automatic installation for one gate, $935. Other bids:

Calif. Corrugated Culvert Co.—(1) $6800, (2) $5500; total, $7350.

Baker Iron Works—(1) $7460, (2) $315; total, $7775.

GRASS VALLEY, CALIF.—R. B. McKenzie, Gerber, submitted low bid to Nevada Irrigation District Oct. 15, at $48,660 for the construction of the Deer Creek Diversion Dam, involving 1050 cu. yds, loose excav., 1300 cu. yds, solid rock excav., 5700 cu. yds. mass concrete, 55 cu. yds. reinf. concr., 3 slide gates installed, one bronze name plate installed. Fred H. Tibbetts. Alaska Commercial Bldg., San Francisco, district engineer. Engineer's estimate, $75,283. Other bids: California Air Constr. Co., Los Angeles, $49,415; W. A. Bechtel, San Francisco, $61,001; E. B. Skeels, Roseville, $67,705; H. C. Whitty, Sanger, $69,150.

Valve: Llewellyn Iron Works, N. Main and Redondo, Los Angeles, awarded contract for furnishing one butterfly valve at $1487. Other bids: Joshua Hendy Iron Works, $1614; Pelton Water Wheel Co., $2121; Water Works Supply Co., $2295; Chapman Valve Mfg. Co., $2685. Engineer's estimate, $2386.

LOS ANGELES, CALIF.—Bids were received by county October 10 for furnishing outlet gates for the Sawpit Dam, involving:

PROPOSAL I:
(1) 2 30-in. needle valves;
(2) 2 18-in. discharge pipes;
(3) 2 30x18-in. special cast tees;
(4) 2 18-in. rising stem extra heavy gate valve;
(5) one 16-in. rising stem extra heavy gate valve;

PROPOSAL II:
(1) 2 30-in. needle valves;
(2) 2 18-in. discharge pipes;
(3) installation:

PROPOSAL III:
(1) 2 30-in. special cast tees.

PROPOSAL IV:
(1) 2 18-in, rising stem, extra heavy gate valves;
(3) one 16-in. rising stem, extra heavy gate valves.

The bids, which were referred to the chief engineer of the flood control department, E. C. Eaton, for tabulation and report were:

Baash-Ross Tool Co.—Proposal II: (1)

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$10,748, (2) $120, (3) $1500; total, $12,368. Proposal III: (1) $1693.

Llewellyn Iron Works—Proposal II: (1) $8800, (2) $140, (3) $1195; total, $10,135. Alternate for item (1) without bronze bull ring, etc., $6200. Proposal III: (1) $1550. Proposal IV: (1) $980, (2) $195; total, $1175. Total cost, $12,860.

Pelton Water Wheel Co.—Proposal II: (1) $8337, (2) $154, (3)—; total, $8491. Proposal III: (1) $1840, (2) $1565. (Darner-Johnson free discharge valve): Proposal IV: (1) $1541, (2) $659, (3) $220; total cost, $12,256 (not including installation); cost, with installation (figured at $1195), $13,451.

Joshua-Hendy Iron Works—Proposal I; (1) $13,168, (2) $113, (3) $1847, (4) $995, (5) $410; Total cost, $16,533. No bids other proposals.

GRASS VALLEY, CALIF.—Morrison-Knudsen Co., Boise, Idaho, submitted low bids to the Nevada Irrigation district, Grass Valley, Sept. 22nd, and was awarded contracts at $154,270 for constructing the Combie Diversion Dam, and at $308,570 for constructing the Big Bear Creek Dam. The work involves:

Contract No. 21—For constructing the Combie Diversion Dam, involving (Proposal A): 5500 cu. yds. loose excav., above elevation 1520; 2500 cu. yds. loose excav., below elevation 1520; 4000 cu. yds. solid rock excav. above elevation 1520; 500 cu. yds. solid rock excav. below elevation 1520; 20,500 cu. yds. mass-concr. in dam; 50 cu. yds. concr. in piers; 110 ft. galv. iron pipe railing 2 slide gates, install; 1 bronze name plate, furnish and install. Proposal B: 6500 cu. yds. loose excav. above elevation 1520; 3500 cu. yds. loose excav. below elevation 1520; 2100 cu. yds. solid rock excav. above elevation 1520; 500 cu. yds. solid rock excav. below elevation 1520; 1200 cu. yds. concr. in cutoffs and foot; 4600 cu. yds. concr. in buttresses; 525 cu. yds. concr. in gravity section; 4150 cu. yds. concr. in face slab, spillway lip, struts, and walkways: 600,000 lbs. reinf. steel 1350 lin. ft, galv. iron pipe railing, furnish and place; 2 slide gates, install; 1 bronze name plate, furn. and install.

Contract No. 22—For constructing the Bear Creek Dam, involving 6 acres clearing; 20,000 cu. yds. stripping; 6000 cu. yds. cutoff excav; 13,800 cu. yds. loose excav. for spillway and outlet works; 11,500 cu. yds. solid rock excav. for spillway and outlet works; 600 lin. ft. outlet conduit; 280,000 cu. yds gravel fill; 46,000 cu. yds. clay facing; 2900 sq yds. asph. concr. facing; 40 cu. yds. concr. in outlet works; 16,000 lbs. miscel. steel work, furnish and place; 1500 cu. yds. concr. in spillway; 121,000 lbs. reinf. steel, placed; 16,000 lbs. outlet gates, placed. Outlet house superstructure, furnish and erect, 1 bronze plate and install.

The bids follow:

Combie Diversion Dam, Proposal A. Arch Type, bids as follows: Morrison-Knudson Co., 319 Broadway, Boise, Idaho (awarded contract), $154,270; E. B. Skeels, $158,134; Jas. Currie, $176,361; Ward Engr. Co., $198,651; Jasper-Stacy Co., $206,348; Utah Constr. Co, $218,970; W. A. Bechtel, $229,938; Gist-Heller Co., $238,305; Robinson, Roberts & Kraner, $250,581; Claude Fisher, $297,000; Engineer's estimate, $190,852.

Combie Diversion Dam, Proposal B, Ambursen Type, bids as follows: E. B. Skeels, $171,458; Jas. Currie, $192,469; Utah Constr. Co., $213,650; Engineer's estimate, $196,-563.

Deer Creek Dam, bids received follow: Morrison-Knudsen Co., 319 Broadway, Boise, Idaho (awarded contract), $308,570; Utah Constr. Co., $349,550; Marsh Bros. & Gardenier, $351,357; Central Constr. Co., $388,-

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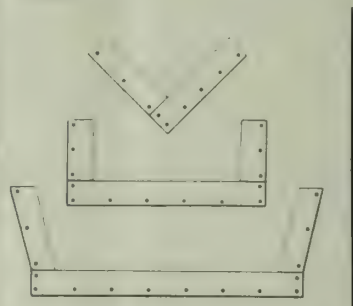

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557; Gist-Heller Co., $391,520 W. A. Bechtel Co., $408,593; Claude Fisher Co., $417,879; Palmer & McBryde, $421,458; Robinson, Roberts & Kraner, $499,089; Engineer's estimate, $339,959.

Fred H. Tibbetts, Alaska Commercial Bldg., San Francisco, is engineer.

Importance of Forests in Water Conservation

(*Continued from Page 45*)

"(2) The regularity of flow of rivers and streams throughout the year depends upon the storage capacity of the watershed, which feeds the stored water to the streams during the summer through underground seepage and by springs. In winter the rivers are fed directly by precipitation, which reaches them chiefly as surface runoff.

"(3) Among the factors, such as climate and character of soil, which affect the storage capacity of a watershed, and therefore the regularity of stream flow, the forest plays an important part, especially on impermeable soils. The mean low stages as well as the moderately high stages in the rivers depend upon the extent of forest cover on the watersheds. The forest tends to equalize the flow throughout the year by making the low stages higher and the high stages lower.

"(4) Floods which are produced by exceptional meteorological conditions cannot be prevented by forests, but without their mitigating influence the floods are more severe and destructive."

Arizona Court Decision Affects Lake Pleasant

(*Continued from Page 47*)

latter ruling, it might be pointed out that seventy second feet amount to 50,400 acre feet per year, and that the estimated capacity of the Lake Pleasant reservoir amounts to only 173,500 acre feet. The plaintiff also has rights to divert surface waters to the amount of 125 second feet, which during the past has yielded approximately 15,000 acre feet. A description of the Lake Pleasant dam and irrigation project was given in detail in December, 1926, and in June, 1927, issues of MODERN IRRIGATION. The average annual discharge of the river at the Lake Pleasant dam site is 254,000 acre feet, but records show that there are enormous differences between the maximum and the minimum, and during years of but slight rainfall, it is highly probable that there will be but sufficient water to supply the prior rights of the Southwest Cotton Company.

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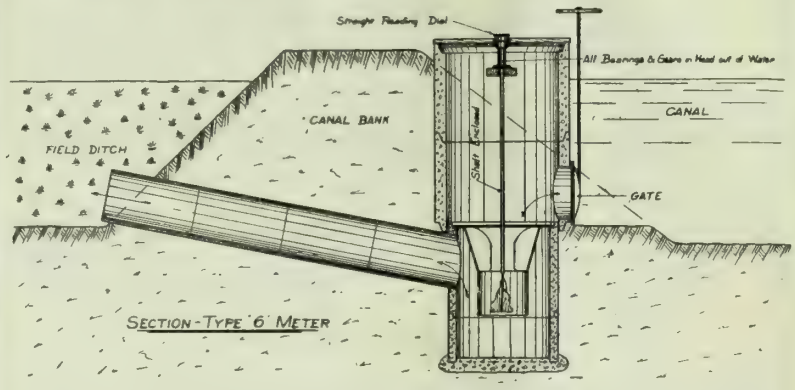

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WHO'S *WHO* AND WHO'S *WHERE*

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Paul Pratt, city engineer of La Habra, California, has been appointed city manager by the council. He will continue to act as city engineer, combining the work of both offices.

Lee Baird, formerly water clerk of the Calipatria division, Imperial irrigation district, California, has been appointed field foreman of the division succeeding D. I. Quick, resigned.

Dr. Elwood Mead, commissioner of reclamation, has returned to the Washington office of the Bureau after a two-months' trip to Palestine for a study of the colonization work of the Zionist organization.

J. C. McDonald, comptroller of water rights in the department of lands, Victoria, British Columbia, recently visited the Okanogan project, Washington, to obtain information relative to reclamation in the northwestern section of the United States.

Rhea Luper, state engineer of Oregon, made a recent inspection trip to the Gold Hill and Fort Vannoy irrigation districts in the southern part of the state. Both these districts have recently asked authority to issue bonds with which to make further developments.

J. L. Lytel, superintendent of the Yakima irrigation project, Washington, left for Washington, D. C., the latter part of October for a conference with Dr. Elwood Mead, commissioner of reclamation, on various matters pertaining to the project. Mr. Lytel expected to be in Washington for two or three weeks.

Associate Engineer D. C. Caylor has been placed in charge of the remaining construction work in the Elephant Butte irrigation district, Rio Grande project, and Assistant Engineer W. M. Bushman has been transferred to the El Paso Valley district where he will assume charge of the remaining construction work in that district.

Milo S. Ketchum, dean of the school of engineering of the University of Illinois, received on November 3 the degree of doctor of science from the University of Colorado, where he was for fifteen years dean of the college of engineering and professor of civil engineering.

William Mulholland, chief engineer of the Los Angeles Bureau of Water and Supply, is now on a vacation trip to Florida and Key West. He took the boat by way of the Panama Canal and stopped off en route at Havana. Mr. Mulholland will make a special trip to

WILLIAM MULHOLLAND
Chief of Los Angeles Bureau Water and Supply.

see the Dix River dam near Danville, Kentucky. Assistant Chief Engineer Van Norman will meet him there and together they expect to make a thorough inspection of the dam. From Kentucky they plan to go to Chicago and from there will return to California.

Lieut. Col. G. R. Lukesh, formerly engineer, Ninth Corps Area, San Francisco, California, has been appointed division engineer of the Northern Pacific Division, with headquarters at Portland, Oregon.

Prof. M. L. Wilson, of the Montana State Agricultural College, is supervising an economic survey of the Montana irrigation projects.

Norman McLean of San Diego and John H. Chase of Riverside, California, have been appointed engineers for the Tia Juana River Irrigation District. Works aggregating about $150,000.00 are contemplated in this district.

Alexander Bell, Pacific Coast manager of the Wallace and Tiernan Company, Inc., left the first week in November for a month's stay at the Wallace and Tiernan factory, Newark, New Jersey.

D. J. Calkins, of the Tacoma office of the U. S. Geological Survey, spent a day recently on the Yakima project, Washington, checking gauging stations maintained by the bureau and obtaining stream flow data.

W. L. ("Bill") Jett, for the past sixteen years Los Angeles manager for Mueller Company, of Decatur, Illinois, has been appointed manager of the Southern Division of the company. Mr. Jett has been with the Mueller Company for twenty-four years.

E. W. Lane, formerly hydraulic engineer for the Mississippi River Spillway Board, with headquarters in New Orleans, has been transferred to the office of the Chief of Engineers, Washington, D. C., for work on the development of a plan for controlling Mississippi River floods. Mr. Lane has had extensive experience in flood control work. From 1914 to 1920 he was engaged in flood prevention studies on the Miami Conservancy District. He next represented the Morgan Engineering Co. on flood prevention and waterway improvement work on the Yangtze and Huai rivers and Grand Canal in China, and in 1924 and 1925 he was assistant engineer, Pueblo flood protection works.

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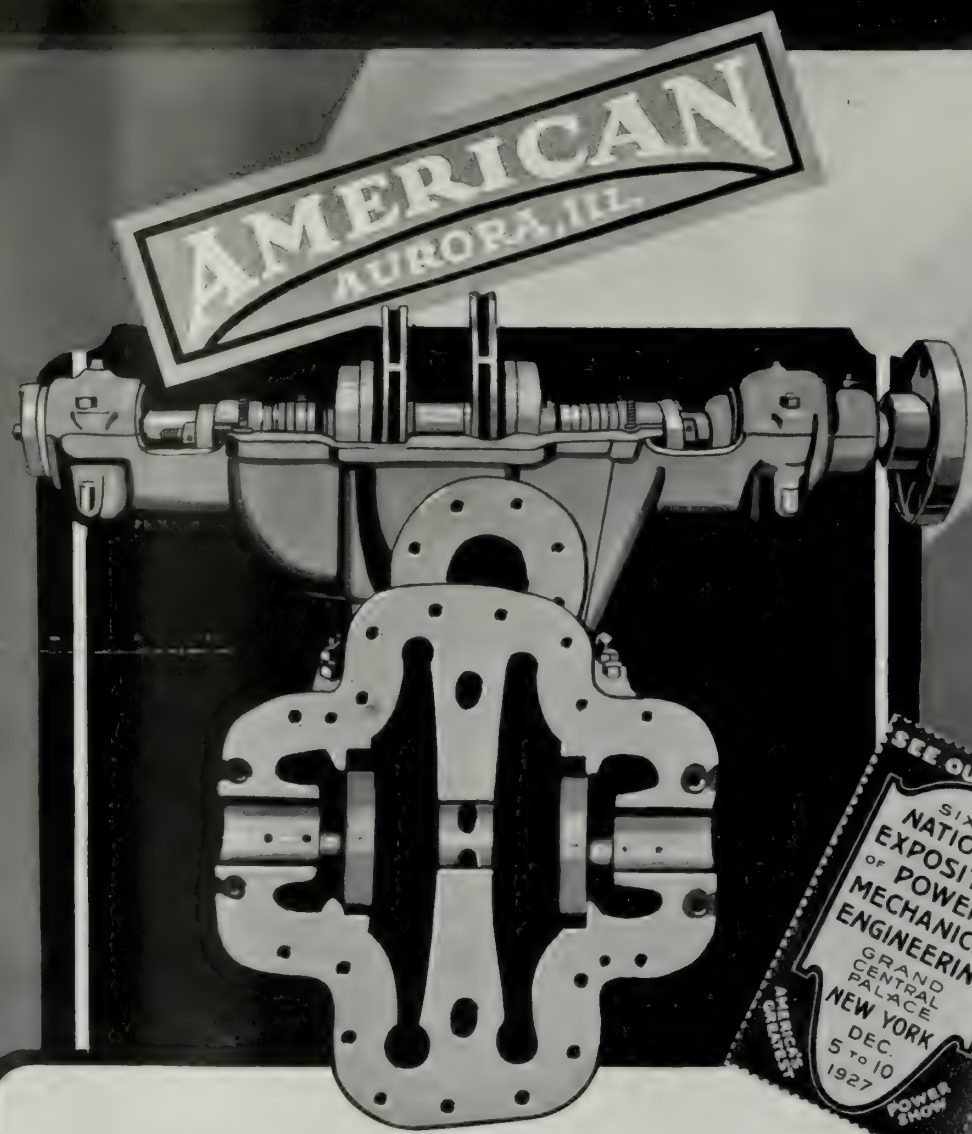

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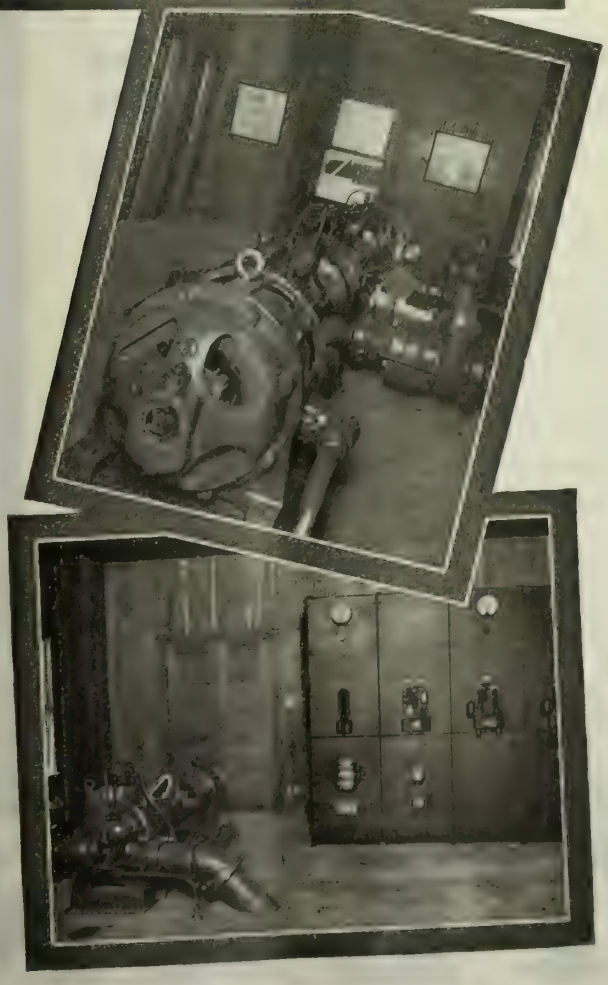

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"Western Waterworks" Section Begins on Page 25

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Contract for installation of 5 miles of 36-inch pipe awarded Nov. 15, 1927

A notable addition to the long list of concrete water supply lines in use by cities of the United States and Canada, part of which are as follows:

	Year Built	Diam. Inches	Length of Line Feet	Head in Feet
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Do.	1915	84	3,000	80
Victoria, B. C.	1915	42	143,000	90
Dallas, Texas	1916	36	14,400	68
Ft. Worth, Texas	1917	36	1,200	60
Do.	1917	48	13,200	60
Seattle, Wash.	1917	42	7,000	90
Hartford, Conn.	1918	48	4,654	60
Winnipeg, Can.	1918	66	49,000	90
Do.	1918	48	11,300	90
Queens (Boro.) N. Y.	1920	15 & 20	8,000	70
Kansas City, Mo.	1920	48	8,000	40
Denver, Colo.	1920	54	26,000	100
Milwaukee, Wisc.	1920	72	2,366	50
St. John, N. B.	1919	42	2,000	
Do.	1921	36	21,600	78
Norfolk, Virginia	1921	36	34,000	150
Cumberland, Md.	1919	36	6,012	60
Do.	1920	36	972	
Do.	1921	24	840	
Do.	1921	36	1,608	100
Do.	1921	36	2,136	100
Do.	1922	36	7,334	70
Do.	1923	36	9,100	180
Do.	1924	36	11,888	180
Tulsa, Oklahoma	1924	54	129,800	115
Do.	1924	60	147,600	105
Greeley, Colorado	1922	27	18,200	118
East Orange, N. J.	1923	20	8,000	115
Denver, Colorado	1924	54	20,000	130
New Bedford, Mass.	1924	60	1,240	23
Portland, Me.	1923	54	500	60
Do.	1924	54	2,950	60
Riverside, Calif.	1927	42	40,000	105
Laguna Beach, Calif.	1927	18-24-27	18,000	150

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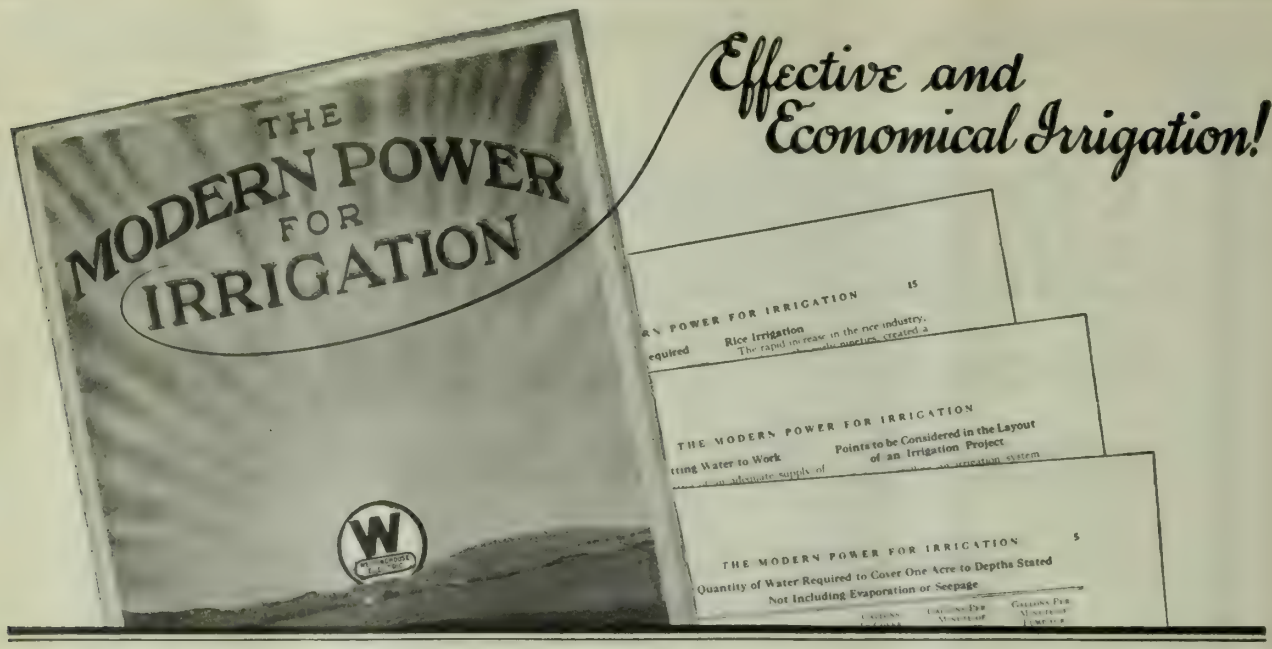

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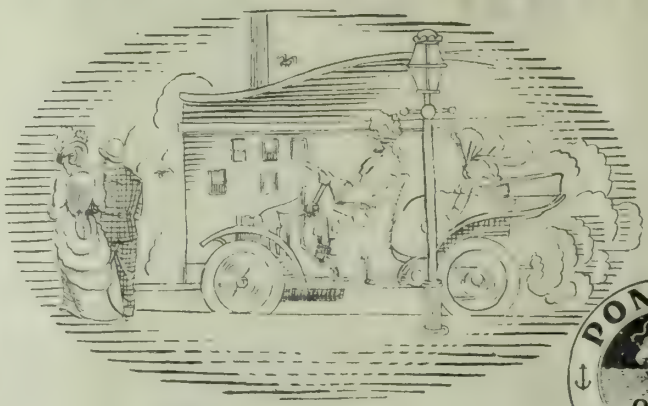

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E. M. BREED

Who, during November, was elected president of the Western Irrigation Equipment Association, at the same retiring as president of the Pacific Hydraulic Engineering Association. Mr. Breed has been a constructive personal factor in hydraulic affairs on the Pacific Coast for many years, and, as sales manager of the Pelton Water Wheel Company of San Francisco and vice president of the Engineers Club of that city, he is widely known in the allied hydro-electric, waterworks and irrigation industries. He is a member of the board of Editorial Advisors of Hydraulic Engineering.

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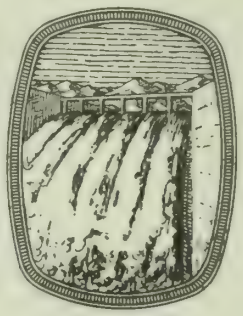

Volume III DECEMBER, 1927 Number 12

A Busy Session For Congress

THE session of Congress which has just opened is likely to bring forth some very constructive legislation pertaining directly to the water resources of this country, and more particularly to those of the west. It will be remembered that the northwest is endeavoring to obtain recognition for the Columbia River Basin Project, and that the southwest requires assistance on the Colorado River Project.

Concerning the Colorado River Project, Secretary Work has often stated that the dam should be constructed with Federal aid and under Federal control.

"The interest of the Federal Government," reports the Secretary, "is based primarily on the fact that the stream is not only interstate but international, that several Federal reclamation projects have been constructed and secure their water from this stream, and the fact that the development involves flood control, irrigation, power development, and domestic water to a very large area.

"Of perhaps primary importance is the protection from floods of Imperial Valley, California, and the Yuma reclamation project, Arizona, with their large investments and tremendous agricultural resources. Incidentally, the same storage will provide water for irrigation of large areas of fertile arid lands and domestic water for southern California.

"Engineers and economists have reached the conclusion that the receipts from irrigation, domestic water, and hydroelectric power developed at such a structure would, in a reasonable period of years, return the entire cost.

"As indicated, the problems are so numerous and varied that interstate and international compacts or treaties were deemed advisable. While the latter was the subject of a bill which received long and careful consideration during the last session of Congress, such compacts have not been finally consummated. In fact at the present time contentions are made by some, which if maintained, might leave the Federal Government without reason to expend further time and money in connection with the project.

"If the rights and privileges incident to such project are purely local and intrastate, there would appear no warrant for the expenditure of Federal moneys for its construction. If, however, as was the view when the departmental investigations and reports were made and the legislation proposed in Congress at its last

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session, the Federal Government has rights and interests, the whole matter should receive further consideration. Therefore, during the past summer there was secured the services of several eminent engineers and attorneys to make individual studies on the situation and individual reports, with the view of being thereby enabled to submit further information relative to this project and its problems.

"These storage works being not only of interstate character but also vital to public interest in their phases of flood control, irrigation, and domestic water supply, and especially in the protection of our international water rights, I deem that the dam should be constructed with Federal aid and under Federal control.

"Moreover, the Federal Government should in all prudence endeavor to recover costs from the power potentialities and other revenues. Lease of the rights to use the water to the highest bidders would be the simplest and best means of reimbursing the government for its outlay."

The Secretary has suggested that if it should prove that no adequate lease could be secured from parties willing to undertake generation and distribution of power, then the government should have the authority to erect the power plant and lease the plant itself, and if no adequate contract of this character could be made, then the government should have the authority to generate and sell the power at the generating station to persons willing to purchase it and provide their own transmission and distribution.

Field Construction of a large sized Steel Pipe line. Note that each joint is wrapped with a protective material before being laid in the ditch.

Bureau of Reclamation

In regard to other problems that must be settled and provided for at this session of Congress, are the various enterprises and projects of the Bureau of Reclamation. This particular department of the government is at present constructing a number of engineering works which in size, cost, and natural obstacles rank among the great projects of the world, according to the report covering the department. The dam on the Owyhee project in Oregon will be higher than any existent structure. These works are a part of a 10 years' program aimed to complete construction on all of the approved projects. The estimated cost of these developments is $97,000,000, and to complete them in 10 years will involve a yearly expenditure of between $9,000,000 and $10,000,000.

During the past fiscal year economic conditions of water users on the projects improved and their relations to the Government became more cordial than they were prior to the passage of the adjustment and amending acts of 1924 and 1925. This has been accomplished by a higher percentage of attainment due the Government, particularly on projects, or divisions of projects turned over to irrigators to manage and maintain. Investing them with this authority and responsibility has improved morale and increased local pride.

Contracts have been executed by 30 irrigation distributors and water users' associations on 16 projects, for the transfer of local control of the care and operation of irrigation works of these projects or divisions of projects. Under these transfers water users will have to raise in advance the money required to operate and maintain the works, which was formerly appropriated from reclamation fund, to be repaid at the end of the year or later. Lessened risk of loss to the Government by having water users advance the money was shown by the fact that the appropriation for operation and maintenance for 1928 was $1,105,000 less than in 1927, and that 1929 will be less than 1928.

The income of the Bureau of Reclamation for the past fiscal year was $9,680,-719.05.

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Economic Development of Laguna District, Mexico, Depends Upon Proper Water Storage

Rich Agricultural District at Mercy of Winter Floods, Which, if Properly Utilized, Would Provide Summer Irrigation for Large Acreage

By JOSE G. VALENZUELA
First Engineer Nazas Water Board
Translation from Spanish by J. de la Fuente

THE so-called "Laguna District" of Mexico is a very extensive and flat valley with a rich alluvial and permeable soil over 1000 feet deep. This soil is the result of the slow deposition of silt and sediments carried in suspension by the flood waters of the Nazas and Aguanaval rivers. The valley slopes gently from the river in all directions and its flat portion has an area of about 4,000 square miles, of which some 500,000 acres are under cultivation. About 30 per cent of the cultivated area is in the State of Durango and 70 per cent in Coahuila State.

Location

Torreon, the principal city of the valley, with a population of 45,000, is in Coahuila, and Gomez Palacio and Lerdo, with 20,000 and 7,000 inhabitants respectively, are in Durango. They are situated at the head of the valley or at the apex of the dejection cone. The Nazas river flows between Gomez Palacio and Lerdo. A good paved road joins them, and a large concrete bridge is soon to be constructed over the Nazas. Coahuila State has two more cities and a town: San Pedro, 40 miles below and northeast of Torreon on the Monterrey Line, with a population of 15,000; Matamoros, 9 miles below and east of Torreon on the old International Railroad, now the Tlahualilo Branch, with 6,000 inhabitants; and Viesca, 50 miles to the southeast on the Coahuila and Pacific Railroad, with about 5,000 inhabitants. Mapimi and Bermejillo are two towns of Durango on the old Central Railroad.

Torreon is the commercial, banking and industrial center, with two local banks and agencies of the Mexico, National of Mexico, London & Mexico, and Land Banks. There are smelters (one at Mapimi, Durango), spinning and weaving mills, cotton compress (three more attached directly to gins of large haciendas), cottonseed oil mills, soap and glycerine factories, the one at Gomez Palacio having 400 tons of seed daily capacity. There is also a guayule rubber factory, and a smaller one in Gomez Palacio.

The Palmito Dam in the Nazas River would provide storage for 1,469,000 acre-feet. This storage basin is shown on the above contour map of the district.

Distances

The distance to El Paso, Texas, is 525 miles; to Eagle Pass, Texas, 375 miles; to Mexico City, 700 miles; to Durango City, 160 miles (from Durango City the railroad line to Mazatlan has been constructed as far as El Salto, a distance of 90 miles); to Monterrey, 240; and to Saltillo, 185 miles. The National Lines of Mexico connect the Laguna District with the above mentioned cities, and local railroad branches cross it in several directions.

All of the farms and haciendas on the cultivated lands are fully equipped with gins, tractors, combines, Decauville roads, mules, etc.

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Flooding lands preparatory to the planting of cotton, near San Pedro, Coahuila. This is a type of large check flooding.

Some of the haciendas, such as Purcell, Santa Teresa, Lequeitio, Tlahualilo, etc., cultivate over 25,000 acres each.

Primary schools are widely extended in every farm. Primary, commercial and high schools have been established in towns and cities, and lately a preparatory school was opened in Torreon with success.

Mean elevation of the valley is about 3,600 feet; mean annual rainfall 8 inches, varying from 3.6 to 17. Summer temperatures run as high as 106 degrees F. and in winter very occasionally drop as low as 20, with very light frosts. The climate is dry and there is a yearly average of about 300 clear days.

The Guadalupe Dam, one of the Poiret type.

The torrential and meandering rivers already mentioned are the basic wealth of the district. The Nazas is about 8 times larger than the Aguanaval in mean annual runoff; its bed is dry most of the year and its flow at the head of the valley varies from a few cubic feet to over 70,000 cubic feet per second when in flood. Two exceptional floods of about 150,000 second feet were recorded in 1860 and 1917.

Observations have been made by the Nazas River Water Board since it was first organized in 1891. This board now functions directly under the water users, and its duties comprise the observation and collection of data of both rivers and the distribution of water under regulations approved since 1895.

The Nazas river floods are distributed through a system of 10 diversion dams and 29 main canals. The San Fernando, Santa Rosa, Calabazas, Coyote and Cuije dams are of rubble masonry of low weir design; the Guadalupe, San Pedro and Colonia dams are of the Poiret type; and the Trasquila and the Cleto are of the Mann type. The capacity of the canals varies greatly from 35 to 3,600 second feet; the size varies from 5 to 60 feet in width at the bottom, with sloping sides of one and one-half to one. Some of the canals are more than 25 miles long.

The amount of water given to each canal is regulated twice daily at the intake gates, which are of modern construction and easily manned. The amount due each concession depends upon the amount of river flow; this is always known with great precision by means of two daily measurements with a Gurley electric current meter and the automatic register of the height of the river water. When the flood is large in volume, each canal is allowed to divert all the water it can carry, and also some of the higher intake gates and openings are used to irrigate directly as overflow and to release the pressure of water below. But there are times when either the flood is large or water is refused because it is inopportune or because the land is all planted. In these cases a large amount of water is lost and

The watershed of the Nazas River, combined with the Ramos River. Above the proposed Palmito Dam site lies an area of 7,430 square miles. This is shown by the above map.

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A panorama of the Nazas Valley. At the extreme left is Durango; at the extreme right lies Coahuila. The Coyote Dam (diversion weir) lies just above the second bridge, as shown by the arrow.

flows into the shallow depression of the closed Nazas watershed called "Mayran Lagoon," about 12 miles below San Pedro and over 300 square miles in area.

The Nazas river watershed above the head of the valley is 13,830 square miles in area, the upper reaches rising on the eastern side of the Sierra Madre. The main affluents are: Santiago, Tepehuanes and Oro rivers. The upper reaches

A pumping plant in the Nazas Valley.

have always some permanent water, but contribute flood waters to the Nazas only during the summer months of high precipitation or from the occasional winter snows, which melt rapidly in these latitudes. Because losses by evaporation and especially by infiltration and percolation are very heavy, all the river flow at low water is used by the small diversion canals before the river enters the valley.

Pumping Conditions

The river bed above the valley and for a distance of more than 40 miles consists of loose gravel and rock to a depth of 120 feet, and in affluents the condition is the same, though the distance and the depth are not so great. The great percolation resulting from this condition feeds the several strata of underground water of the valley below the ground water, as has been proved by more than 130 wells that are producing from 900 to 3,000 gallons per minute, at a pumping depth of from 25 to 80 feet and at a cost of $40 to $100 per acre. At the head of the valley and within 15 miles below it, the pumping depth varies from 25 to 45 feet. The heavy percolation—probably as high as 60 and 70 per cent—induced by the inundation system of irrigation and permeability, also feeds the underground basin. Waters of lower strata rise to the level of ground water.

The principal agricultural products in their order of importance are: cotton, alfalfa, wheat, etc. Since 1850 cotton has been the main crop. At first, and as new lands were opened, the production was over a bale per acre, but the one-crop system and the pests (pink boll worm, boll weevil, leaf worm, etc.,) diminished production to just over a half bale per acre. The varying runoff of rivers bringing excesses and depressions, the emigration and immigration of workers, the demand for higher wages in wet years, etc., make agriculture a very uncertain business.

A partial remedy (a complement to flood control) is the individual development of underground water. This makes possible May and June irrigation of cotton planted in February and March, which, as experience has demonstrated, often doubles present production per unit of surface. Through the use of underground water crop rotation is made possible, and there is no necessity for decreasing plantings when the river runoff is small or inopportune. But this method is limited to the proven pumping field of over 300,000 acres at a reasonable depth and 5-year loans for such improvements.

Irrigation is practiced by flooding the

President Calles (in center with panama hat) inspects a pumping plant near Las Vegas, Coahuila, on the property of J. Vargas and Sons.

opened lands by means of checks made by borders or levees of 3 feet high and more and of variable area from 50 to 1000 acres and over. This method has several disadvantages: floods arrive

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The Rio Nazas near Torreon. This picture was taken during the 1923 flood. The Coyote Weir is shown in the foreground.

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Arable Lands of Kittitas Valley, Washington, Will Soon be Placed Under Irrigation

Reclamation Bureau Undertaking Development of New Division to Yakima Project Involving Over 100,000 Acres

By WALKER R. YOUNG
Construction Engineer, U. S. B. R.

THE Kittitas Division of the Yakima Project, now under construction, includes the arable lands of the Kittitas Valley in the state of Washington with the exception of the bottom lands which have been irrigated from the Yakima River for many years. The main body of land to be included in the new project ranges in elevation from 1700 to 2100 feet and surrounds the present irrigated lands in the form of an elliptical ring, with the town of Ellensburg occupying a central position.

The new division includes close to 100,000 acres, of which approximately 72,000 acres are estimated to be irrigable, including about 2500 acres above the canal that will no doubt be irrigated by pumping from the canal. Of the irrigable area, approximately 58,250 acres are in private ownership; 6,750 acres are owned by the Northern Pacific Railway Company and its subsidiary the Northwestern Improvement Company; 5,400 acres are public lands; and 1,600 acres are State lands.

Transportation Facilities

The Kittitas Division is favored with excellent transportation facilities by reason of its area being traversed by two principal highways and two main transcontinental railways—the Northern Pacific and the Chicago, Milwaukee and St. Paul. The marketing prospects are likewise good, since the center of the project is only 120 miles distant from Puget Sound, making it reasonable to expect that surplus valley products will find cheap and ready markets in the Pacific Coast cities and region west of the Cascade Mountains. The natural conditions of soil and climate support a diversified agriculture. Small grains, alfalfa, clover, timothy, potatoes, and in fact, all crops common to the temperate zone produce profitably. In favored locations, apples, pears and cherries are grown commercially. There is probably no section of this country which produces higher yields of wheat and oats, when these crops are irrigated. At the present time hay is the principal valley crop and a considerable portion of this product is consumed locally, in wintering and preparing for market large numbers of sheep and cattle which find summer range in the neighboring hills.

Water will be supplied to the project from the natural flow of the Yakima River, supplemented by storage from reservoirs at Keechelus and Kachess Lakes now functioning in connection with the operation of the Yakima Project. Diversion into the Kittitas Main Canal will be effected at the foot of the Cascade Mountains through the construction of a dam just above the town of Easton.

Main Canal

The Main Canal, as being constructed, parallels the Yakima River, on the south side, for a distance of approximately 26 miles. The North Branch Canal then carries the bulk of the water across the river in an inverted siphon and around the north and east sides of the Kittitas Valley, about 36 miles, to the Wippel Pumping Plant. From here three branches are carried around Badger Pocket, terminating at the mouth of the Yakima River Canyon, 6 miles southeast of Ellensburg.

The South Branch Canal will divert from the Main Canal approximately one mile above the Yakima River Siphon and continue down the south side of Kittitas Valley about 14 miles to Menastash Creek. From here to the Yakima River Canyon delivery will probably be made by a main lateral.

Gravity Type Dam

The dam, as designed, is a straight gravity type, concrete structure having an overall length of about 250 feet and raising the water surface approximately 43 feet above low water in the river. The water surface in the pond above will be controlled by the use of a drum type, automatic gate, 64 feet long by 14.5 feet high, mounted on top of the Ogee crest of the dam. With the gate lowered the designed spillway capacity is 13,000 second feet. Flow into the Main Canal will be regulated by two, 12 foot by 11 foot radial gates. Provision is made for two, 4.8 by 8 foot sluice gates at river level, and for a fish ladder in the north abutment.

At the point of diversion the Main Canal will have a capacity of 1320 second feet, requiring a bottom width of 30 feet and water depth of 11.35 feet in unlined earth section. About 50 per cent of the Main Canal will be lined with reinforced concrete. Near the head of the canal the lined section will have a bottom width of 12 feet and water depth of 9.75 feet.

Just below the point of diversion the

A moveable frame was built which expedited the work of tying the re-inforcing bars at the joints, during the construction of the Main Canal, Kittitas Division.

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Main Canal will pass under the Northern Pacific and Chicago, Milwaukee and St. Paul Railway tracks which parallel the river on the south side at the diversion dam site. The crossing will be made in tunnels. Construction of the canal involves some heavy side hill excavation and 9 inverted siphons across creeks and canyons. These siphons range in size up to 13 feet in diameter and will operate under heads up to approximately 245 feet. On the North Branch Canal the outstanding feature is the siphon in which 925 second feet of water will be carried across the Yakima River in a steel pipe or pressure tunnel some 3300 feet in length, under a hydrostatic head of 350 to perhaps 550 feet, depending upon the plan adopted. Several tunnels and wasteways are required along the line of the canal. At Wippel Creek, a portion of the water will be lifted by a direct connected turbine and pumping plant to irrigate lands above the gravity canal in Badger Pocket. A small portion of the North Branch Canal and of the South Branch Canal will be concrete lined.

The active construction period began in April, 1926, following a thorough investigation of the feasibility of the project from an engineering and economic standpoint. Construction was undertaken by the Bureau of Reclamation under the provisions of two principal contracts with the Kittitas Reclamation District, a public corporation, duly organized and existing under the laws of the State of Washington.

Terms of Contract

On February 16, 1921, the Kittitas Reclamation District entered into a contract with the United States for the purchase of 260,000 acre-feet of water per annum, for which payment is to be made in 40 semi-annual installments. The exact amount to be paid is to be determined later, but the probable cost was stated as $1,710,000.

A contract dated December 19, 1925, between the United States and the Kittitas Reclamation District, provides that the former will expend not to exceed $9,000,000 in the construction of a diversion dam and distribution system,—the lateral system to be built as the Secretary of the Interior finds necessary and possible of construction within the limited expenditure. The obligation of the United States is contingent upon Congress appropriating, annually, the necessary funds. The United States is to utilize its ditch and canal rights of way reserved by the Act of August 30, 1890 (26 Stat., 391). Any other rights of way needed are, if desired, to be obtained by the District, but the cost thereof is to be paid by the United States as a part of the construction cost.

The above shows the use of moveable wooden trestles and steel forms for transporting and placing concrete during the construction of the Main Canal, Kittitas Division.

As required by law the Secretary of the Interior is to issue two public notices relative to the construction charges. The first public notice is to be issued when the land is ready for settlement and will announce the construction charge per irrigable acre, and the second is to be issued when, in the opinion of the Secretary, the agricultural development of the lands shall have advanced sufficiently to warrant the commencement of the payment of installments of the construction charge. The second public notice will fix the date when payments will begin on the construction charge announced by the first public notice, but this date can not be more than five years later than the date of the first public notice.

Construction Charges

The contract provides that all construction charges shall be made payable in annual installments based on the productive power of the land. The annual installments of the construction charge per irrigable acre are fixed at 5 per cent of the average gross annual income for the preceding 10 calendar years, or for all years of record if fewer than 10 are available, of the area in cultivation in the division or subdivision of the project in which located, as found by the Secretary annually. The annual payments are to continue until the total construction charges are repaid.

After the completion of the construction program, the district is to operate and maintain the irrigation works. The United States is to have the right to inspect the works and to require the district to make needed repairs, or the United States may make such repairs and charge the cost to the district.

The district is to levy assessments or taxes upon the land in the district in order to raise the money needed to make payments to the United States. The district is obligated to make the payments, notwithstanding the default of some of the landowners in meeting their assessments. The Government may refuse to deliver water to the district if it defaults for a period of more than one year in any payment due to the United States under the contract. Or, if the Government prefers, it may reduce the amount of water delivered proportionately, and the district is then to refuse to deliver water to landowners who are more than one year in default in the payment of any of their water charges.

Form of Management

In order to protect the United States during the period when the construction charges are not paid in full, the district is to employ an irrigation manager who is to be satisfactory to the United States and who may be discharged if he is found by the Secretary of the Interior to be incompetent or otherwise unsatisfactory.

One great difficulty with all old projects constructed by the Government under the reclamation laws has been due to speculation. The land, during the construction period, came into the hands of those who did not desire to farm it themselves, but to sell it to others at boom prices, owing to the expectation of benefits from the expected water supply. When the Government's debt began to mature, the land was very frequently found in the hands of an owner who had bought at an enhanced price expecting to sell at a still higher price, and who had made but a small payment for the land and had given a mortgage for the remainder. Since this transaction was based upon an inflated valuation of the land and since the landowner was faced by an indebtedness both for the

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The Don Pedro Dam, built by the Turlock Irrigation District in 1923. The Turlock Irrigation District was the first of its kind to operate under the Wright of California.

Phenomenal Agricultural Growth of California Attributed to Scientific Usage of Water

Intensive and Intelligent Application of Water to Arid Lands Places California Agriculturists in Enviable Financial Position

By EDWARD HYATT, JR.
State Engineer of California

THE position of California among the wealth producing states of the nation is directly attributable to the phenomenal growth of agriculture in this state, which has been brought about by the scientific application of water to the land and the intensive and intelligent cultivation of the soil by the California farmer.

The limit of profit by dry farming was reached in 1885, and it is since that time that irrigation has been intensively practiced in the State of California. The phenomenal growth and expansion of irrigated areas necessitated the construction of dams, diversion works, canals and other works of such magnitude that their initial cost prohibited their being undertaken by individuals. Their construction and financing has been accomplished through associated effort, which has been made possible through the California Irrigation District Act, pased in 1897 and amended in 1913, and the California Bond Certification Act, passed in 1913.

These acts provide for the approval of organization of districts and supervision of construction by the State Engineer, and the approval and certification of bonds by the California Bond Certification Commission, of which the State Engineer is a member.

The Exchequer Dam, shown above, was built to secure for the Merced Irrigation District a dependable water supply for the irrigation of the 190,000 acres within its boundaries.

The Division of Engineering and Irrigation is and has been closely associated with the phenomenal growth of California, which is among the leading wealth producing states of a nation which leads the world in agriculture. During the past generation most of all the proposals for irrigation development undertaken by collective effort have had their adequacy and general merit concurred with, if satisfactory, or rejected, if defective, by the division.

Huge Investments Approved

In carrying out its statutory functions millions of dollars worth of improvements are approved every year by the Division of Engineering and Irrigation. It analyzes and passes upon plans of irrigation, drainage, water storage, water conservation and reclamation districts. The certification of irrigation district bonds by the California Bond Certification Commission

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Removal of Sulphur from Well Water is Problem Confronting Beverly Hills

Extensive Experimental Work Conducted by City Leads to Construction of Large Filtration Plant

By RAY L. DERBY

Engineer, Salisbury, Bradshaw & Taylor.

RAY L. DERBY

Sanitary Engineer of the firm of Salisbury, Bradshaw & Taylor, Consulting Engineers of Los Angeles, who are in charge of the Beverly Hills investigations.

THE problem of removal of sulphur from well water in most cases consists of an aeration treatment, and that is all, as it usually does not amount to very much. The average will probably run around one to two parts per million. In Beverly Hills, however, the sulphur content of the water averages ten parts per million, and some of the wells run twenty or more. This condition brings about a great deal of trouble. When we aerate the water, the sulphur is liberated to the air and the neighbors around the aeration plant put in a strong protest. Beverly Hills has the combined problem of removal of hydrogen sulphide from both air and water.

As far as aeration is concerned, the best type of spray nozzle we have used at Beverly has given only about 65 per cent efficiency of removal. Another type that we used, the Sacramento, did not give us as high an efficiency (about 50 per cent), but the head consumption was very much less. On a test of seven different types of nozzles the Sacramento, with about 55 gallons a minute flow, consumed a five foot head with 50 per cent removal of H_2S. The next best nozzle gave 60 per cent removal but consumed something like 14 feet, and from that they ranged to 20 feet to care for 55 gallons per minute. In no case did the efficiency exceed 63 per cent. As w had to pump our water from wells we decided on the Sacramento type, and have been using that for the past two or three years.

Construction of Spray Head

The first mistake we made was to construct it of cast iron. Iron and sulphur combine and form iron-sulphide, which roughs up the nozzle orifice so that it does not give the uniformly fine spray needed for the removal of the trouble. This precipitation of iron-sulphide necessitated cleaning out the nozzles once a week.

All of the nozzles in the new plant which is going to be built, and some bought about six months ago to replace old ones, worn out in two years, have been made of bronze. The bronze nozzles have not been cleaned for four or five months, and are still giving as good a spray as when put in.

The water, averaging before treatment ten parts of sulphur per million, is reduced by aeration to about four parts. We further reduce it on about two hours retention to two and one-half parts per million, and on experimental work we have allowed it to stand from 12 to 14 hours and have reduced the sulphide to one part per million, or even less.

Effects of Retention

The big trouble with retention was that it afforded a wonderful opportunity for the sulphur bacteria or beggiatoa to grow. Very shortly after our present aeration plant was put in operation we began to get complaints from consumers, not only of hydrogen sulphide but in some cases of a musty or moldy taste or odor like water from rain-barrels or wet gunny sacks. An investigation of the complaints showed a husky growth of beggiatoa on the walls of the plant and in the wells. Both were covered with it, and in the basins there were masses of it. In appearance it was a good deal like the ordinary waste with which you clean machinery; some of the streamers grew two or three feet long. We had to clean the basins on an average of every ten days. The water would be good for about five days after cleaning and then would get bad again.

After aeration and retention we tried chlorination to cut down the H_2S. That worked fairly well, but with hydrogen sulphide the action that takes place on addition of chlorine is the precipitation of free sulphur. Chlorine killed off all the beggiatoa, and the sulphides and free sulphur in the water and the dead beggiatoa went out in the pipe lines. Then it was found that hydrogen sulphide forming bacteria were present and they formed fresh hydrogen sulphide so that the trouble was about as bad as before and in some cases worse.

The water in our aeration plant about a year ago would run about one part or a part and a half per million, and in the outlying sections of the city it showed three or four parts per million, the increase being due to the hydrogen sulphide forming bacteria as explained above.

The reaction of the hydrogen sulphide on the pipe would produce iron sulphide lightly adhering thereto; and slight change of velocity, like the filling of a swimming pool, would turn a quantity loose. This was annoying to the housewife, and especially so on a Monday morning when she would perhaps get a tub full of black water on her white clothes, with consequently violent results in the water department office.

We put in a chlorine machine a year ago, and used about 20 pounds of chlorine per day on the aeration plant. It would have been better, perhaps, to chlorinate the water direct from the wells, but we were using about 5,000,000 gallons per day, with a hydrogen sulphide

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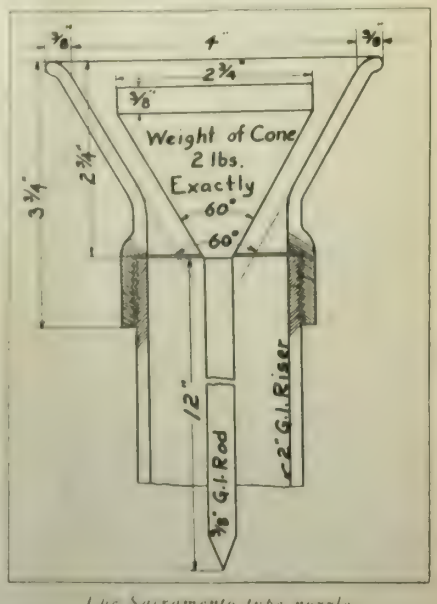

The Sacramento type nozzle

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The EDITORIAL

HYDRAULIC Engineering
MODERN IRRIGATION • WESTERN WATERWORKS

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Riparian Rights

A DOCTRINE of riparian water rights, as a part of the common law of England, slowly evolved from immemorial usage and custom, to meet conditions prevailing in England before the United States existed as a nation. The common law doctrine of riparian rights, while no doubt fitting as well as might be for the needs and conditions of England years ago, or even modern England where there are but few rainless periods during the year, but where frequent summer rains keep the country verdant, was certainly not suited to the needs and conditions of the California of 1850, and more certainly not suited to the needs and conditions of the California of today with its semi-arid climate.

Briefly, and stripped of its legal verbiage, riparian rights are those which are supposed to arise from the ownership of lands bordering upon the banks of a stream; each such owner, but no one else, is entitled to a part of the flow; none of the riparian owners can take water out of their own community—that is, of the watershed of the stream: this right is considered as attached to and running with the land; and whether the water is used or not, each such riparian owner is entitled to see the stream flow past his land unchanged in quantity and quality from its natural condition. —The doctrine of riparian rights, carried to a strictly logical conclusion, means that waters in California cannot be used for any purpose at all except upon riparian lands in the actual watershed of the stream they flow in. Under a strict construction of riparian rights, many million acres of productive land in California must remain dry and barren.

In 1914 there was issued the Water Commission Act, which squarely faced the issue of appropriation of water versus riparian rights, and declared that all waters not already in legal use, and all public waters, were open to appropriation under procedure established by the act. This act, and subsequent amendments, was probably the greatest step forward in constructive legislation that has been made along this line.

Irrigation in the Nile Valley

A LARGE irrigation project to be developed upon the Blue Nile has recently been announced. An American company was named as the successful bidder upon this work, which it is estimated will require five years to complete, and necessitate the expenditure of over $20,000,000.

The Nile has annually inundated Egyptian farm lands, but owing to the inaccessibility of its source, and because the flooding was considered by the Egyptians as a phenomenon upon which their religious system was partially founded, the actual cause was not determined for many years. Today, we know the cause of these inundations: the torrential rains, and the melting snows in the mountains of equatorial Africa.

Lacking rain, Egypt depended entirely upon the Nile, and when, as in the years of famine, it failed to inundate the country, Egyptian prosperity faded. But for Joseph it would have been quickly depopulated, either from decimation of its inhabitants or their removal elsewhere. The immense supplies of grain in storage from more successful years alone prevented Egyptian eclipse. The full harvests from these better years undoubtedly robbed the virgin soil, but with new inundations, harvests continued as before.

Without water soil is of little or no value. Under the blazing sun of Egypt, day in and day out, the Egyptian farmer somehow managed to produce a crop. It is wondered how this could be possible, for following the recession of the floods, the surface would rapidly become dry. The answer is to be found in the fact that these floods covered the land for months. The silt from the mountains, being deposited upon the lands, was entirely water-soaked and lay for a long time under the influence of the floods. Long before the Egyptian farmer might venture upon the land to prepare a seed bed, or plant his crops, such an abundant reserve of moisture had been provided by the pressure of the flood waters, that the soil was thoroughly soaked to a great depth. As a result,

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POINT *Of* VIEW

under the influence of the equatorial sun, the Nile valley became a sort of a hot-house, wherein all vegetable life sprang to rapid and luxuriant growth, such as made Egypt the wonder and envy of the world of the ancients. The Egyptian farmer was provided with two essentials every year, the most wonderfully productive soil ever known, and an abundance of moisture to nourish growth, besides the necessary intense heat to bring it to maturity. Under such conditions, human life would seem unbearable, but ocean currents undoubtedly modified the climate.

The result is read in history. Egypt became the greatest power of its day. Its wealth and magnificence have been the subject of songs, stories, and dramatization. Irrigation was not unknown to the Egyptians, but such practice consisted in the erection of shallow dams to hold a part of the flood waters, and short canals to lead the water to where it might be needed. But in main part, inundation took the place of irrigation along the Nile.

The fall of Egypt from its pinnacle of fame came after a succession of years when the Nile failed to inundate the lands sufficiently for the usual production of crops, and famine followed. Other nations took the leadership, which they have held ever since that time. The lands in the various valleys of the Nile are still of virgin soil, and only require the intelligent application of water to make them produce in bountiful abundance.

A few years ago considerable interest was aroused in regard to the irrigation of the Nile valley because of the crisis in Egypt. One of the items of the demand made by Great Britain on Egypt following the assassination of the Sirdar, Sir Lee Stack, was that the area to be irrigated at Gezira in the Sudan would have to be increased from 300,000 feddans (a feddan approximates one acre) "to an unlimited figure." This demand was later withdrawn and submitted to an independent commission for settlement. Objections to this demand were raised in Egypt to this increase because it was thought that the necessary diversion of the Nile water would imperil the existence of Egypt. A correspondent of the London Times pointed out that these fears were entirely unfounded, and states: "The system devised for securing water from the Nile for the Sudan provides for the use of flood water, which, if superabundant, is an actual danger to the riparian agriculturist in Egypt, and in any case runs to waste in the Mediterranean.

"The area known as the Gezira is situated between the Blue Nile and the White Nile immediately south of Khartum. Excellent Egyptian cotton has been successfully grown in this district for many years, irrigated by means of pumps, but only small areas of a thousand feddans. It is estimated that there are probably 3,000,000 feddans in the Gezira on which cotton could be grown."

Surveys have indicated that a dam could be built on the upper reaches of the Blue Nile which would afford storage for some six million acre feet. This storage, after allowing for three million acre feet to be held in reserve to meet emergencies such as an exceptionally low flood, would release three million acre feet annually for additional irrigation in the Gezira. This would be more than sufficient to mature a cotton crop on a 300,000 feddan area in the Gezira plain without drawing upon the river flow at any time. This water would be taken from the Nile when at flood time, and when the water would normally be discharging into the sea. This means that it should be possible to irrigate at least one million feddans altogether in the Gezira, of which one third would be under cotton each year, while at the same time no water would be drawn from the Nile at any period when Egypt could not spare it.

There is a large area of land known as the Gezira Plain, which contains from three to four million acres, all being capable of cultivation by irrigation. This plain has a well-defined fall from the Blue Nile in the east to the White Nile in the west, which simplifies the problem for irrigation and drainage.

The scheme for cotton growing in the Gezira was initiated by Lord Kitchener and an agreement was entered into with a group of capitalists to provide money for developing the undertaking.

The land of the Nile is probably due for one of the largest irrigation and hydraulic developments in the history of the country, and the recent $20,000,000 contract is but a forerunner of others that will undoubtedly be announced during the next few years.

Use of Reclamation Fund

STATEMENTS have been current in the press about the failure of the Reclamation Fund to revolve and the impression widely prevails that obligations of the water users on the Federal irrigation projects are not being met. Wherever this impression is held it is erroneous. Since the passage of the Adjustment Act, payments of the full amounts due the Government are the rule and delinquencies the exception.

An illustration of this is furnished in the receipt by the Bureau of Reclamation of a check for $708,951.14 from the Salt River Valley Water Users' Association in payment of one year's construction charges of the Salt River irrigation project, Arizona.

This check is for the largest amount ever received on yearly construction payments in the history of the Bureau of Reclamation. It makes certain that the payments of construction charges by the water users on the Federal irrigation projects for the fiscal year 1928 will be greater than in any previous year.

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Accurate Record of Hydraulic Resources in State Needed for Industrial Development

Washington Engineer Outlines Necessity for Continuance of Stream Gauging and Topographic Mapping in Connection With Irrigation Development

By JOSEPH JACOBS
Consulting Engineer, Seattle, Washington

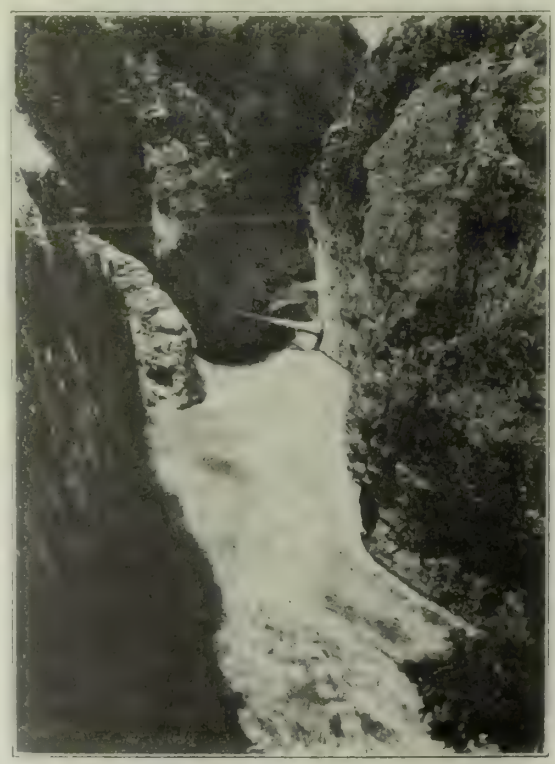
AS an engineer who has investigated a great many irrigation, power and water-supply projects in the State of Washington, I can say unequivocally that our greatest handicap in these investigations is a lack of dependable technical data, that ought to be readily available, upon which the merit of the enterprise must be predicated and proven. We ought to be forehanded and definitely prepared to meet the legitimate demands of capital seeking investments in enterprises which are dependent on a knowledge of what our water and land resources are.

The protection of the public interest in the development of the states water resources is a paramount duty of the state. This can only be done through definite knowledge of what we have. These interests are of such a high order of value—beyond that of any other state in the Union in respect of water power—that it would be most unfortunate, and indeed expensive, should the state fail to make an early and a thorough going inventory of its natural resources and their possible development, particularly its water supplies and their potentialities for domestic, irrigation, power and navigation uses.

We have thus far mapped only one-half of our state area and at the rate we are progressing it will take at least forty years to complete it. We are today, despite the increased need for them, maintaining fewer stations and doing less of stream gauging work than we were ten years ago. The dry cycle through which we have lately been passing has served to emphasize how essential it is to have a correct estimate of the yield of our streams, and of our sub-surface water supplies as well, in order that we may plan our developments wisely and with out danger of future loss.

Pacific Coast Development

The Pacific Coast is now on the eve of a marked industrial development. Factories and capital are seeking those places on this western border where natural resources are to be developed and where the most definite forecasts and estimates of the future can be made, which means where the most extensive and dependable data have been secured and compiled. Washington, with its expansive potentialities, has expended far less than any of her neighbor states in the study of her water resources. During the past six years Idaho's appropriation for stream-gauging work has been more than double that of Washington and even Oregon, with scarcely more than one-half our population, has exceeded our appropriation by about 20 per cent. California, during the same six year period, has prosecuted her regular stream-gauging schedule at a cost of $185,000, or practically four times our appropriation, and in addition has expended $440,000 in special investigations of her water resources and their possible development.



The Skagit River at Diablo Canyon now being developed for power by the City of Seattle, Washington.

The time is now here for this state to take a definite step forward in the matter of topographic mapping and of stream-gauging including a broadened study of our underground water resources. We would be woefully derelict if we did not at this time embark upon a wholesome program to secure, within a reasonable time, these basic data which are so indispensable to all of our future development, both agricultural and industrial, if we really desire to convert potential possibilities into actualities. We believe that our topographic mapping should be completed within a period of at least 20 years, thus conforming to the federal plan as contemplated in the Temple Act—the federal government doing the work and bearing one-half the cost. We have thus far completed in the state about 46 thirty minute quadrangle sheets, or about 36,000 square miles, and there yet remains to be done almost an equal area.

Similarly we must expand and hasten our stream-gauging work. Our "Stream Flow Committee" gave this matter detailed consideration and, as you have seen from the report of that committee, it is proposed to establish all necessary stations within a period of 6 years at an aggregate cost of $165,000 and it is estimated that the maintenance cost of the old and new stations during that period will amount to $148,000. This means a total of $313,000 or about $104,000 per biennium, and of this amount it is anticipated that the federal government and private agencies will supply about one-quarter, thus leaving only three-quarters to be provided by the state. The topographic mapping, on the basis of 2 thirty minute sheets per year, will cost about $90,000 per biennium and of this it is anticipated that the federal government will pay one-half. The total requirement from the State for these two activities is, there-

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"Western Waterworks" Section Begins on Page 25

W a t e r

—from the time it falls as rain or snow or is pumped from underground reserves, until harnessed by man for various industrial uses—that is the important field and province of HYDRAULIC ENGINEERING.

Water—the life's blood of the irrigation, waterworks and hydro-electric industries—that necessary ingredient which has caused the building of giant dams and reservoirs throughout Western America and other parts of the World; the installation of countless motors, pumps, Diesels and other prime movers; and the construction of a vast network of canals, pipe-lines and penstocks; of such, also, is the editorial bone and sinew of this publication.

Webster's Dictionary defines the adjective HYDRAULIC: "Of or pertaining to hydraulics or fluids in motion; conveying, or acting by, water; operated, moved, or effected by means of water . . . " And the noun HYDRAULICS as "That branch of science, or of engineering, which treats of water or other fluids in motion, its action in rivers and canals, the works and machinery for conducting or raising it, its use in driving machinery, etc. . . ."

With such a broad field of editorial endeavor, it is interesting to note the general classes of equipment and materials which can be advertised to advantage in HYDRAULIC ENGINEERING. For the benefit of those who are planning advertising campaigns to reach the hydraulic engineers, executives and constructionists of the irrigation, waterworks and hydro-electric industries, a partial list of such products are given below. The readers of this publication are vitally interested in, and are consistent large-scale purchasers of, the following equipment:

EXCAVATING EQUIPMENT: Shovels, cranes, trenchers, draglines; also special bucket types and wire rope.

TECHNICAL PAINTS AND COATINGS, CEMENT HARDENERS, WATERPROOFERS, ETC.

HYDRAULIC PUMPS, AIR LIFTS, all types.

ELECTRIC MOTORS, including control devices.

DIESEL ENGINES.

PIPE: Steel, Copper, Wood, Clay, Iron and Concrete—all types, for water and sewer lines.

METERS, GAUGES, RECORDERS: All types for water measurement; also meter boxes.

GATES, HYDRANTS, VALVES, PIPE FITTINGS: All types for the hydraulic industries.

WATER FILTRATION AND PURIFICATION EQUIPMENT.

POWER PLANT EQUIPMENT: TURBINES, WATER WHEELS, NEEDLE VALVES, ETC.

CONSTRUCTION MATERIALS AND EQUIPMENT: All types used in building dams, flumes, canals, etc.

WELDING EQUIPMENT.

TRACTORS.

BALL AND ROLLER BEARINGS for pumps and prime movers.

OILS, GASOLINE, GREASES: Used in the three major hydraulic industries: irrigation, waterworks, hydro-electric.

WELL DRILLING EQUIPMENT: Rigs, tools, etc.

WATERWORKS EQUIPMENT: Of special types, like tapping machines, pipe clamps, jacks, caulking substances, etc.

ENGINEERING AND CONSTRUCTION FIRMS, building dams, power plants, etc.

MECHANICAL RUBBER GOODS: Rubber bearings, packing, belting, valve cups, hose, etc.

GAS ENGINES: For construction equipment, well rigs, etc.

HOISTS: For dam construction, etc.

CEMENT: For dams, canals, reservoirs, power houses.

EXPLOSIVES and Blasting Equipment.

Reg. U. S. Pat. Off.

"Western Waterworks" Section Begins on Page 25

Survey Reveals Necessity for Watershed Protection as a Conservation Measure

A Southern California County Organizes Protective League Whose Members Will Co-operate with Forestry Officials

By HAROLD E. WAHLBERG

County Agent, U. S. Department of Agriculture.

FORESTRY consciousness is the present day need in all communities, rural and urban. To this end the Orange County Farm Bureau and the Agricultural Extension Service have included in their program of work the advancement of water conservation and flood control through watershed coverage and protection, in cooperation with county, state and federal agencies that are directing the work in the forest areas.

Of the 508,000 acres comprising the area of Orange County, about 90,000 acres lie in the forest reserve. 350,000 acres, or nearly 65 per cent of the gross area of the county may be considered agricultural land. This is by far the highest percentage of any county in Southern California. Normally about 120,000 acres are now supplied with irrigation water. There has been a rapid growth in the development of irrigation in the past three decades. Government reports show that in 1905 there were about 40,000 acres under irrigation; in 1910 about 55,000 acres; in 1920—90,000 acres, and at present about 120,000 acres. The favorable topography of the valley plains in the county encouraged the early development of irrigation on a large scale. When the gravity flow of the Santa Ana River and the minor streams of the county were appropriated long ago, hundreds of wells were sunk to tap the underground water supply, which was at one time comparatively close to the surface.

Wells Furnish Most Water

There are now about 2500 wells drawing on the underground water bearing gravels, which supply about 80 per cent of the water used by farms and cities within the bounds of the county. The other 20 per cent comes by gravity flow. The best estimates of engineers indicate that the total amount of water used annually lies between 250,000 and 260,000 acre feet. The Santa Ana River furnishes the largest portion of the supply. Smaller amounts are contributed by the Santiago Creek, a tributary to the Santa Ana; and the Trabuco and San Juan Creeks in the southern part of the county. With the rainfall on the valley floor, these provide the present water resources of the district.

Engineers' estimates on the average annual production from the above sources are presented as follows:

Santa Ana River	153,000	acre feet
Trabuco and San Juan	14,200	" "
Santiago Creek	8,800	" "
Foothill runoff	3,000	" "
Valley Floor	40,000	" "
Total	219,000	" "

This total does not take into consideration the ground water return or the estimated loss due to evaporation, but since they are about equal, namely 40,000 acre-feet per annum, according to estimates, the production of 219,00 acre-feet may be considered net. The estimated average annual runoff into the ocean, following peak storms, is 20,000 acre-feet, which when deducted from the annual production leaves a net of 199,000 acre-feet.

PAUL BAILEY

Chief Engineer of the newly organized Orange County Flood Control District.

If the present irrigation development in Orange County requires 250,000 acre feet, it will be clearly seen that the overdraught amounts to about 50,000 acre-feet per year, and explains very vividly the cause of lowering water levels. The possibility of maintaining, if not increasing, an adequate water supply for the present acreage will depend on three factors.

1. More economic and scientific use of irrigation waters.
2. Effective flood control program.
3. Watershed protection and reforestation.

During the past decade considerable light has been thrown on the effect of too frequent irrigation on tree crops, particularly in citrus production. Scores of groves have deteriorated in thrift and production because of excessive use of water. The agricultural Extension Service has demonstrated in numerous instances the benefits from better and more conservative irrigation practice. The net result has been a saving in the aggregate amount of water used in some districts.

New Flood Control Engineer

The board of supervisors has recently employed one of the state's outstanding hydraulic engineers, Paul Bailey, formerly state engineer. The supervisors have recognized the water conservation problem for several years and have taken many progressive steps toward the eventual consummation of a practical and economic conservation and flood control program. Their participation in the spreading work below Mill Creek, with San Bernardino and Riverside counties and the intensive survey of the Santa Ana river in cooperation with the state, are further evidences of vouchsafing the future development of the county.

Watershed Protection

Since over 90,000 acres are in the Cleveland Forest Reservation and almost a similar area of watershed country privately owned, there is another important angle to the Orange County conservation problem. It is that of protecting the hillside brush and other covering from fire destruction. Here lies the big job of the Forestry Division. Their rangers and officials ever alert are continually preparing for emergencies by

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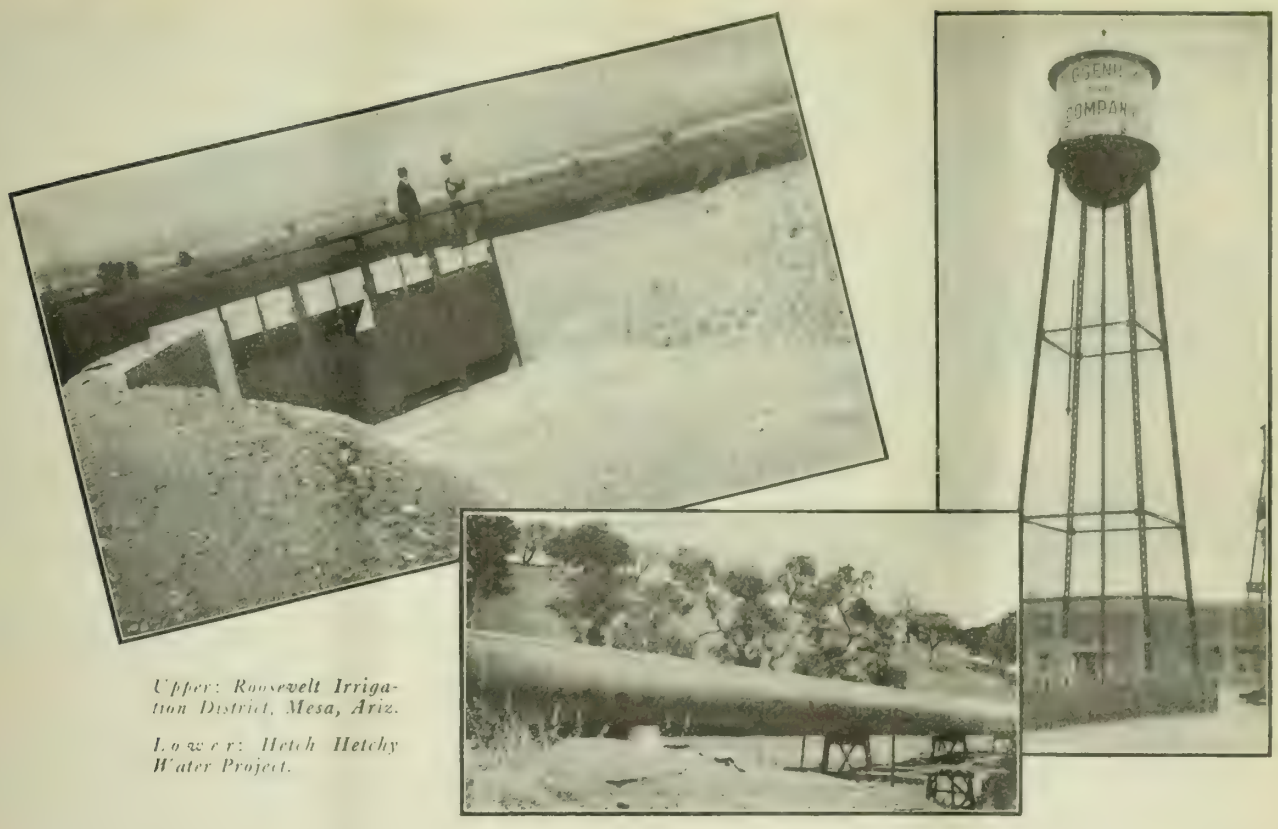

Upper: Roosevelt Irrigation District, Mesa, Ariz.

Lower: Hetch Hetchy Water Project.

NATION'S ANNUAL CORROSION TOLL
Reaches Staggering Sum

Replacement costs probably 1/3 of new installations

Corrosion due to the disintegrating action of fresh and salt water, acids, alkalis in the soil and electrolysis adds a tremendous sum annually to the nation's upkeep bill on pipe lines, concrete reservoirs, irrigation and hydro-electric projects, acid, brine and water tanks and many other exposed surfaces. This upkeep amounts to hundreds of millions each year.

The problem of combating corrosion is a vital one that is being solved more and more by the proper use of protective coatings such as Hill, Hubbell & Company's Biturine Enamel.

Biturine Enamel is a heavy, quick setting bituminous coating applied hot. It is impervious to the corrosive action of acid, alkalis and electrolysis.

Biturine Enamel has been used for more than 16 years on many of the West's largest construction projects. Lake Washington Ship Canal Locks at Seattle and the Hetch Hetchy Water Supply Project pipe lines are both protected by Biturine.

Biturine Enamel is supplied with directions. Easily applied. No skilled labor necessary.

Valuable practical data and specifications free on request.

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Developing the Kittitas Division, Yakima Project

(*Continued from page 15*)

land and for the water, he was often doomed to fail.

Preventing Land Inflation

In an endeavor to prevent the land values from being inflated in this way, the contract with the Kittitas Reclamation District provides for an appraisal of the land by a board of three appraisers, one appointed by the Secretary of the Interior, one by the district, and a third member selected by these two. This board has appraised all of the district lands, without regard to the prospective water right. If lands are later improved by the erection of buildings, etc., the added improvements may be appraised at the expense of the landowner. When land in the district is sold the vendor and vendee are to report the facts of the sale to the district and land is to have no right to receive water from the project works unless such report is made.

If, after the appraisal, any land is sold at a price in excess of the value fixed in the appraisal, plus any water-right payments made, one-half of such excess is to be paid to the district and is to be applicable upon the water-right charges. This is based upon the just theory that the project expenditure was responsible for such enhancement in value and therefore the project should share in the profit arising from the sale of the land. The provision will undoubtedly have a tendency to prevent a runaway boom in land values such as crippled some of the older projects for a considerable period.

Method of Appraisal

The appraisal board took into consideration the quality of the soil, the topography (which indicates the cost and difficulties encountered in preparing land for irrigation), and the nature and value of improvements, if any, on the various tracts. This appraisement thus becomes an inventory of the value of the project in its undeveloped state and an index to its productive power under irrigation.

According to the terms of a contract dated December 19, 1925, between the United States and the State of Washington, the state assumes the duty and responsibility of promoting the development and settlement of the Kittitas Division after completion, including the subdivision of lands held in private ownership by any individual in excess of 160 irrigable acres, and the securing, selection, and financing of settlers to enable them to purchase the required livestock, equipment and supplies, and to improve the lands so as to render them habitable and productive. The State is to provide funds necessary for the purpose, but not in excess of $300,000. The State's obligation is contingent upon the Legislature appropriating the necessary funds from year to year.

Size of Farm Units

It has been concluded that, with certain exceptions, farm units on the Kittitas Division should rarely be less than 60 to 80 acres in extent on the best-grade soils and that where the areas of poorer soils are considered, 160 acres may be needed to make a farm that will yield an income sufficient for the support of a family. Under the terms of the contract with the District, water can not be delivered to more than 160 acres in one ownership.

It is believed that the type of agriculture developed in the Kittitas Valley will attract a high quality settler, and should result in the establishments of a permanent and substantial farm community. As the area included in the Kittitas Division practically surrounds a body of land where irrigation has been practiced successfully for a good many years and whose center is at Ellensburg, county-seat of Kittitas County, the educational and social conditions of the project are already well advanced and the problem is largely one of extension of the present facilities.

The population of Kittitas County is estimated at 20,000, over half the people residing in five cities and towns, of which Ellensburg is the largest. The educational facilities are unusually good, there are churches representing all the leading denominations, electric light and power are available, the district is well covered with telephone lines, and there are various facilities for promoting and maintaining the general health of the community. The County Agent and the Kittitas County Farm Bureau constitute the present sources of direct assistance to settlers and the media thru which technical aid is rendered by extension workers and specialists of the State of Washington, the U. S. Department of Agriculture, and the U. S. Bureau of Biological Survey. The services of agriculturists employed by the Northern Pacific and Milwaukee railways are also occasionally available. Although organized in 1919 as an extension organization, the Kittitas County Farm Bureau has since acquired an independent status and enlarged its activities to include cooperative purchasing of farm supplies, cooperative marketing of farm products, and measures for influencing legislation, tax reduction, etc.

Land Settlement

It was realized that the success of the project and the prompt repayment of project costs, will be greatly influenced by the measures taken to secure settlers. It is probable that the privately owned, partially improved land can be settled by the landowners themselves, with the assistance of the Chamber of Commerce of Ellensburg, and other related and interested agencies but this is not true on the railroad, State and public land. This land has an irregular surface, is covered with sage brush, and farms must be built up from the beginning.

It has been estimated that the farmers who take this unimproved land will have to spend money or the equivalent of it to the extent of $5,000 to $7,000 on 60 or 80 acres to bring it into profitable production. This is needed to clear, level, and prepare land for irrigation. It is needed to assist in the erection of houses and barns, and other improvements, and to completely equip the farm with livestock and modern tools and implements. It is not expected that settlers can be secured who have that much capital. Past experience indicates that few settlers will have enough to completely develop their farms. Settlers who have from $1,500 to $3,000 must be encouraged to settle at Kittitas. Because this was realized from the beginning, the State of Washington has entered into a contract with the United States to secure settlers for this division, and agrees to assist these settlers to become established. It was estimated that $300,000 would be needed to settle the raw land at and adjacent to Badger Pocket, located at the easterly end of the project. A discussion of the plan proposed for the development and settlement of the Badger Pocket area may be of interest at this time since the plan is unique in some respects, although not new.

Badger Pocket Plan

In Badger Pocket, there is a compact body of undeveloped land of which the Government, State, and Northern Pacific Railway Company, collectively, own about 50 per cent. Within the boundaries are 8,360 acres, of which approximately 6,000 acres lie under the Kittitas Canals. According to recent maps, the privately owned lands are held by 24 individuals, but in some cases several tracts are controlled by one person with the result that negotiations in connection with subdivision will probably not involve more than 12 or 15 individual owners.

In general, the land is characterized by rough topography and is at present covered with sage brush, so that an unusual opportunity is afforded for the application of a directed plan of settlement in which the size and shape of farms would be fixed in accordance with the topography and productive capacity of the land, keeping in mind also the limit-

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"Western Waterworks" Section Begins on Page 25

WESTERN Waterworks
Supplement to Hydraulic Engineering
Of Interest Expressly to Waterworks Executives, Contractors, and Municipal Engineers

Protecting a Water Supply Where Watershed is Used as Playground of Large City

Unusual Problems Confront the Management of the Marin Water District to Maintain Clean, Potable Water

By JOHN BURT
Manager Marin Water District.

THE watershed from which our Marin Municipal Water District supply is obtained covers an area of 10,450 acres. We have now under condemnation proceedings the land adjacent to this area consisting of 5050 acres, making a total of 15,500 acres. This land is situated on the slopes of Mount Tamalpais. The mountain stands out prominently in the Coast Range of hills to the north of the Golden Gate, overlooking the entrance to San Francisco harbor. It seems to be a natural rain maker, as the records show the average rainfall for the last forty-seven years has been 55.73 inches. The steep character of the slopes has produced an average runoff from 1912 to 1927 of 61 per cent.

To protect this area as a watershed for a domestic water supply is an exceptionally difficult task, as the mountains are used as a play-ground by thousands of hikers and automobile parties that come from San Francisco, Oakland and all surrounding cities and towns. There is a hotel at the summit, a railroad from Mill Valley to the top, a boulevard traversing its entire backbone and a county road that follows the shore lines of one of the lakes for several miles. These public highways and the many trails leading to the top from all sides of the mountain bring many people to our county every week end, and it requires constant vigilance to keep this area free from contamination and to protect it from fires during the dry summer months.

This land is owned by the Water District, and is for the most part covered with a heavy growth of brush, huckleberry, manzanita and wild lilac, and with trees such as redwood, madrone, laurel and oak. It is all in the state game refuge. Deer are abundant and our three lakes are stocked with trout, of several varieties, by the state.

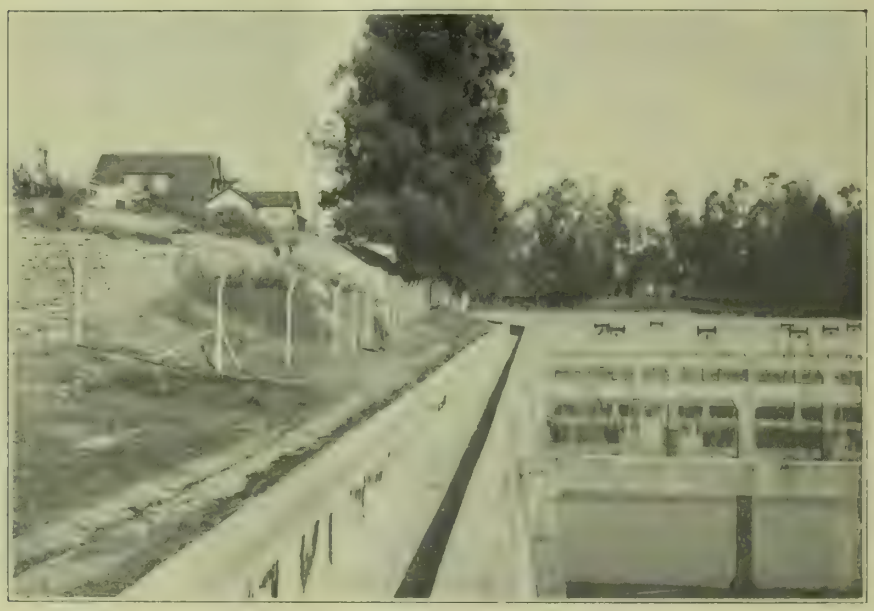
JOHN BURT
Manager Marin Water District

We have three patrolmen and one look-out man regularly employed and in addition to these we have the assistance of the fire wardens that are in the employ of the Tamalpais Forest Fire District. The game wardens also help us in many ways and at many times, as do many of the hikers who belong to hiking clubs that are interested in keeping the mountain for a public play-ground and a beauty spot where they may come for recreation and nature study.

There are no human habitations on our watershed lands, except those necessary for the patrolmen, and the strictest sanitary regulations are observed in connection with them. The drainage from the land on which the hotel at the summit is located does not come into our watershed area, but is carried off through a ravine that we do not use to the Pacific Ocean.

On the very top of the east peak of the mountain is located a look-out station that is occupied by a man who is

(Continued on Page 35)



Showing guard wall at the Bellevue Reservoir.

Storage of Water in Large Population Center Requires Unusual Protection

Fencing of Reservoirs, and Elaborate By-passing System for Storm Waters Have Been Installed by Los Angeles

By DR. CARL WILSON

Director Biological Laboratory—Los Angeles.

JUST what measures shall be adopted for the protection of watersheds seems to me to depend upon circumstances, for each reservoir is a problem which in some respects must differ from all others.

Consider the case of our Haiwee reservoir. It has a catchment area above the point of diversion from Owens River of 3300 square miles, upon which the population is less than two per square mile. Sixty-five miles of open conduit brings the water from the intake across the desert to the reservoir, which is in a barren unpopulated wilderness where the annual rainfall is less than three inches. It is perched upon a divide, with a dam at each end. The lake is seven and a half miles long, divided into three distinct basins which preclude the possibility of water short-circuiting from inlet to outlet. Storage here is never less than three months, while additional time is afforded in lower reservoirs before water reaches the consumer. Natural purification processes have every opportunity here for completion of their work. What protection of this watershed is required to safeguard the citizens of Los Angeles, two hundred miles away? None, other than to prevent the sewage of Bishop, Big Pine, Independence and Lone Pine from directly entering the river or the conduit above the reservoir. To spend money on such a watershed would be an unjustifiable waste.

In contrast to this is our Lake Hollywood, lying on the edge of the city and wholly within the metropolitan district. The catchment area is slightly less than one square mile, located in Weid Canyon, on the flank of Cahuenga Peak. The desirability of the surrounding sharply sloping hillsides for residential purposes has been greatly enhanced by the creation of a beautiful lake and already many palatial homes have been built overlooking the water. Within a short time all the basin outside the city's property will be dotted with houses, with a resident population larger than that of many California towns. Water from this reservoir goes into service fifteen minutes after it enters the outlet tower. What protection is required here? Surely the maximum degree.

Between these extremes we have reservoirs whose surroundings differ greatly from those I have described, with no two quite alike.

Reservoirs in Two Classes

It is natural, then, for us to divide our reservoirs into two classes, storage and distribution, and to treat them differently in the matter of sanitary regulations. Our policies in regard to both classes are definite, but they cannot be considered final in details, for as the region develops we have to modify our ideas.

Our storage reservoirs are all situated where there are no communities upon the tributary watershed, so we have no sewage problems to solve. We must prevent pollution by domestic animals and by campers and ranchers. Water from storage reservoirs generally passes through a distribution reservoir before entering service, and usually receives some measure of purification just before being sent to the consumer.

This being the case we require the effluent from storage reservoirs to be good enough to place no undue burden upon the purification process, but more than that is not necessary. To achieve this end the protective measures are few, and we have not felt it necessary to own large areas surrounding our lakes. The California health laws are very comprehensive and clear. They wisely place the burden of preventing pollution of domestic waters upon the individual, not upon the water purveyor, and we find it quite as easy under the protection of these laws to prevent nuisances upon privately owned land as upon ground belonging to our Department. We feel under such circumstances we are not justified in sinking immense sums of money in needless ownership of land.

The above shows the type of storm wall in use at the Silver Lake reservoir. This wall converts a street into a storm drain, and positively prevents surface run-off from reaching the lake.

Here in Southern California property values have risen so rapidly and to such high figures, that a municipality can afford to own only barely as much land as is required to satisfy the purpose in hand. Perhaps a private water company may properly hold large areas for the combined purpose of protecting its reservoirs and as an investment upon which it is hoped to profit in the future.

A paper presented at the 5th Annual Convention of the [illegible], Section, A. W. W. A., San Luis Obispo.

Municipalities are not looking for profits of this type, and would surely be criticized for purchasing large tracts of property for the sake of accomplishing an object which might be more cheaply obtained in some other manner. If we hold real estate we must pay taxes upon it, and it may be urged that we should put such property to some useful purpose instead of permitting it to remain fallow. Eastern practice has shown us that perfectly safe water may be drawn from heavily populated watersheds, and in the future it will be necessary for us to operate under similar conditions. I believe we should begin now to handle our works so that a heavy population near our reservoirs cannot jeopardize the safety of our supply.

Reservoir Protection

Our policy demands fencing of all storage reservoirs, and this detail is an accomplished fact. Each reservoir is patrolled by a resident keeper, while sanitary inspections are frequently made by inspectors from the Sanitation Division. Hunting, fishing, boating, bathing, picnicking are prohibited on all reservoirs operated by the Department, and this restriction is rigidly enforced. Over one hundred and fifty convictions for violation of this rule were obtained during the spring and summer of 1927.

Grazing is prohibited within half a

A new fence has been erected around the pressure break at the Bellevue reservoir.

mile of storage reservoirs, but where circumstances show sufficient menace this distance is increased. No difficulties in enforcing this regulation have yet been encountered beyond that of convincing stock owners that we mean business. Once they realize we are in earnest they cease to annoy.

Leaching type cesspools are not permitted within 250 feet of storage reservoirs, or of waterways leading thereto. This regulation must, however, be flexible, for under some circumstances it may be prudent to extend the distance to 500

A concrete wall was built around the Hollywood reservoir, as shown above. This wall is four feet above the roadway, but is much higher on the water side, and also functions as a retaining wall. The boathouse shown in the foreground houses the five specially designed boats which apply chemical treatment to the reservoir water.

or 1000 feet, or in some soils to entirely prohibit such disposal. Properly constructed earth vaults are approved at distances greater than 250 feet.

Reforestation has not yet been undertaken by the City of Los Angeles, although hundreds of trees have been planted around our reservoirs for ornamental purposes. The principle of tree planting on a large scale over catchment areas is approved by the Department as a water conserving measure, but we own no areas where such planting could advantageously be done.

Our policy regarding distribution reservoirs calls for fencing with strong wire mesh supported on steel posts set in concrete, and so designed as to make it very difficult, if not impossible, for anyone to climb over them. Several of the most important reservoirs have already been so treated, and others are now being fenced. Gates are kept locked, and the public is denied all use of the reservoir property except passage over the roadways. Resident keepers are maintained at all distribution reservoirs, and inspectors from the Sanitation Division make more frequent rounds than at storage reservoirs.

An elaborate by-pass system for storm water has been constructed around several of these reservoirs, and plans are made for protecting the others in a similar manner in the near future. At Lake Hollywood, and Silver Lake a substantial reinforced concrete wall ranging from two to several feet high, has been built as a curb along the water side of an encircling highway, thus converting the paved street into a storm drain.

Sanitary sewers are required for residences within the drainage area, to carry sewage outside the reservoir basin. Where collecting or intercepting sewers pass near the water and are thought to constitute a menace, they are constructed of cast iron pipe with lead joints, laid under approval of engineers and inspectors from the Water Department. In order to obtain the necessary checks upon sewers we have a co-operative arrange-

Showing the chlorination house at the outlet of Lake Hollywood. The meter house is shown at the left.

ment with the City Engineer which works very satisfactorily. Before plans for a new subdivision or for sewer extensions can be recorded they are sent to the

(Continued on Page 38)

Entire Elimination of Cross-Connections Held Necessary as Safeguard to Public Health

Health Authorities and Waterworks Officials Think Possible Solution Lies in Use of Dual Supply

By J. D. DE COSTA

Assistant Sanitary Engineer—East Bay Water Company.

THE term cross connection as used in this discussion may be briefly defined as a physical connection between a public and private water supply whereby a flow of water from the private to the public system is possible.

The distribution system of East Bay Water Company is cross connected with approximately four hundred private or secondary supplies. The waters from these privately owned sources vary widely in physical appearance, mineral content and bacterial quality. Some are reasonably safe whereas others are dangerously polluted.

Where the object is to develop large volumes of cheap water for some industrial use, or fire protection, little or no consideration is given to its sanitary quality. Shallow wells inadequately protected against the inflow of surface drainage and in the proximity of sewers are a common occurrence. Numerous installations obtain their water directly from creeks and the estuary, (which is a salt water branch of San Francisco Bay) which sources of supply are subject to contamination at all times.

The cross connections are made by the consumer for convenience and reliability of operation and without reasonable precautions for the protection of public health. In fact the usual procedure is to use the easiest, cheapest and most direct means of connecting the two systems. Secondary supplies, of course have a legitimate use, but in the writer's opinion only when such supplies are safely separated from the public water system.

Considered as Dangerous

East Bay Water Company officials have for many years considered cross connections a potential danger to the health of the community and have done everything within their jurisdiction to abate the ever increasing menace. The fight has been uphill and fought single handed. Private individuals are not as a rule prone to listen to the advice of a public utility where such advice affects them in terms of dollars and cents or inconvenience of operation. They immediately form the opinion that the public utility merely wishes to further its own interests.

When check valves were in vogue an extensive survey was made of the then existing cross connections and a request made that check valves of approved design be installed. The company met with strong opposition and after about two years of costly investigations the campaign ended with approximately thirty percent complying with our request. It should be understood that we had no authority to force the issue.

Sanitary Conditions

Early in 1926 we decided to attack the problem from a different angle. Samples of water were collected from the more conspicuous private fresh water supplies in the various East Bay cities, and bacterial and partial chemical analyses made. A total of 102 sources of supply were sampled. The results of the bacterial analyses may be briefly summarized as follows:

Of the 102 samples collected and analyzed

23.5% showed 100% positive colon
7.8% showed 75% positive colon
5.9% showed 50% positive colon
16.5% showed 25% positive colon

or 53.7 percent of the sample analyzed showed colon.

Of the samples not showing colon nineteen percent showed an agar count in excess of 100 bacteria per cubic centimeter.

The result of these analyses brought to our minds more forcibly than ever before the apparent danger to public health and the necessity for a more definite and positive program for removing the source of danger. We have learned through experience that check valves do not furnish adequate protection. Regular inspections of check valve installations show that they do not offer more than seventy-five percent protection. Similar experiences have been obtained elsewhere. In fact they are no longer recognized as a safety measure by health authorities.

Laws Necessary

The ultimate solution is obviously to discontinue the practice of cross connections entirely; in fact to disconnect those existing and prevent new installations. To carry out such a program, health laws governing connections and police powers to enforce them are necessary. The company being without proper jurisdiction, application was made to those with authority for assistance. First we presented our problem and laboratory findings to the State Department of Public Health, and together we gave the subject a great deal of thought and study and after months of deliberation concluded that the existing regulation, although never given a trial, was not practical of enforcement on a large scale. (Reference to the State Board Regulation).

We next brought the matter to the attention of the local health officers. Some professed total ignorance of the existence of cross connections in their city, and none fully appreciated the seriousness and extent of dual supplies. After making a few investigations, however, they were all in agreement that potential danger existed and that the secondary supply should be separated from the public system. More than one year has elapsed and no definite action has been taken. In the meantime the number of cross connections and dangers attached thereto have steadily increased.

What is the answer? Can it be that the public in general is not interested in the safety of its water supply, or is it that the water works men and public health officers upon whom the public depends for a safe water, are negligent in the performance of their task? Surely we will all agree that if the public knew the dangers they are exposed to they would rise in arms against further use of cross connections. The answer then must be that those entrusted to safeguard the public health have overlooked one important source of contamination in permitting the practice of cross connections.

Interest in Dual Supply

Health and water works officials throughout the country are taking an active interest in dual supplies, especially in those states or localities where serious outbreaks of typhoid fever and other intestinal diseases have occurred as a re-

(Continued on Page 34)

Rigid Sanitary Supervision of a Watershed Necessary for a Pure Water Supply

East Bay Water Company Owns Major Portion of its Watershed Lands and in This Way Exercises Close Supervision

By GEORGE HAWLEY

Assistant Chief Engineer—East Bay Water Company.

THE East Bay Water Company has a developed domestic and industrial water supply of 42,000,000 gallons daily to meet the requirements of the municipalities and unincorporated territory lying on the easterly side of San Francisco bay. Approximately 30,000,000 gallons daily of this total supply are obtained from a catchment area of about eight square miles lying in the westerly part of Contra Costa and Alameda counties. The lands lying within the catchment area may be classified generally as wooded hill areas, grazing lands, and agricultural lands and are sparsely settled.

Storage reservoirs totaling 33,000,000,000 gallons capacity provide for a long period of detention of run-off from these catchment areas. All water supplied from these sources is filtered in rapid sand filtration plants and the waters are further subjected to chlorine disinfection.

The Water Company early in its history adopted a policy of acquiring the major portions of the watershed lands, thereby securing control and jurisdiction over sanitary conditions, fire hazards and supervision of property rights. Jurisdiction over the sanitary and fire hazards of lands not owned by the company is made available through state authority and through cooperation with the owners.

Sanitation

The Water Company, cognizant of the ever increasing public demand for a safe water with a high degree of purity and appreciative of the aestheticism and sentimentality of the public, maintains a strict and rigid sanitary supervision over all watershed lands. A definite inspection and patrol policy, conforming with approved sanitary requirements and with the rules and regulations established by law, has been adopted. This control is exercised upon the tenants who lease company lands, private land owners and persons entering upon or traversing the watershed lands. These rules and regulations in part require:

1. The installation and maintenance of sewage disposal facilities of an approved type located not less than 200 feet from any body of stored water or water course. The effluent from these disposal plants must at all times be maintained beneath the ground surface or sterilized and covered.

2. Garbage and household refuse must be burned or buried and covered to a depth of not less than two feet and at a distance not less than 100 feet from any stream or waterway.

3. Carcasses of dead animals must be burned or buried and covered with a soil depth of two feet and at a distance greater than 500 feet from any stored water or waterway.

4. No poisoned bait, animal or vegetable matter except poisoned grain for the extermination of rodents is used on the land of the company and then only under the supervision of the person in charge of lands.

5. Hunting, fishing, boating and swimming is prohibited on the properties and streams under the control of the company.

6. The right to enter upon or traverse the watershed lands under the control of the company requires a permit which is granted for educational or scientific purposes only.

7. All animal industries upon the lands are regulated as to location and their activities must conform to the legal requirements for the protection of lands used for the production of public water supplies.

8. Sanitary supervision is maintained over utilities and other construction organizations working upon or through the watershed lands.

Three major safeguards are employed to protect the water supply: First, protection of supply against contamination at its source; second, long period detention in storage reservoirs; third, filtration and disinfection with chlorine.

The effectiveness of sanitary patrol is well illustrated by the fact that the B. coli content of the raw water is well within the Treasury Department's standards of purity.

Fire Protection

The benefits and advantages that result from the elimination of fire hazards and decrease in fire losses upon watershed lands are manifold and warrant the adoption and maintenance of an adequate fire prevention policy and organization. The denudation of horticultural growth and control of soil erosion have a marked effect upon runoff, evaporation and reservoir silting. With such a policy, personal and property losses are maintained at a minimum.

An ever present and real source of great fire danger and hazard to the East Bay municipalities has been eliminated by the organization of satisfactory and well organized protective measures in the adjoining back country.

Interested individuals, companies and municipalities, realizing the fire hazard that would result from an unprotected watershed area, organized the Contra Costa Hills Fire Protection Committee. The purpose of this committee is the supervision of fire prevention and fire fighting activities necessary to protect the lives and property within the district. This committee functions under the supervision and with the approval and authority of the Federal, State and University of California divisions of forestry.

A District Forest Ranger is in direct charge for the committee and supervises and enforces the state laws which have to do with fire hazards and fire fighting. Permits for burning are issued by the ranger only after inspection and upon the conditions imposed. If necessary instructions are given for safe burning.

Two siren equipped fire towers are located at the points of highest elevation on the watershed areas and a man is continually on duty in these towers throughout the fire season. Complete fire fighting equipment and tools are maintained at readily accessible points of vantage throughout the fire area. This organization functioning as it does under state authority is authorized to draft the needed personnel to combat any fire within the area.

As a corollary to sanitary and fire protection activities, control over hunters, fishermen, picknickers, hikers, campers, etc., tends towards the elimination of trespassing and to the consequent protection of the lives and property of the land owners.

Organization

The Water Company maintains a separate and complete organization for the enforcement of its watershed protective policies.

(Continued on Page 36)

A paper presented at the 8th Annual Convention, California Section, A. W. W. A., San Jose, Calif.

METERS & METERING

An Outline of Methods Used for Making Flow Tests From Fire Hydrants

Pitot Tube Method, as Adopted by National Board of Fire Underwriters, Proves More Satisfactory for Rapid Work

By R. C. STANGE

Chief Engineer—National Board Fire Underwriters.

IN connection with the reports which the National Board of Fire Underwriters issues on the fire-fighting facilities of the various cities of the United States, one of the most important items is an estimate of the amount of water available for fire protection, in excess of the normal demands of domestic consumption. At the time the work of issuing these fire protection reports was inaugurated, no practical method had been devised of measuring this flow. Calculations could be made in some instances, but in a well gridironed system these became much involved and in addition necessitated the making of assumptions which were likely to produce misleading results.

The present method of conducting flow tests, as practiced by engineers of the National Board and also by nearly all insurance rating organizations, is a development of the method of measuring discharges from fire department nozzles by means of a Pitot tube and gauge, originated by John R. Freeman and used in various other ways, such as the testing of fire department pumpers. It is possible to measure discharge from hydrants with a considerable degree of accuracy by the same method used in testing fire engines, that is by the use of short lengths of hose and large smooth-bore nozzles. However, this scheme would necessitate much time, labor and equipment, and in distribution systems where the normal pressure carried is low, only a small part of the total quantity available for engine supply may be obtained in this manner. For these reasons and in order that a number of representative tests might be made in a reasonable time and with a reasonable number of men, the present system of measuring discharges from open hydrant outlets was worked out.

A paper presented at the 8th Annual Convention, California Section A. W. W. A., San Jose, Calif.

The equipment necessary consists of a hydrant cap tapped out to take a pressure gauge, four Pitot blades, four 50 pound gauges and a 200 pound gauge. The Pitot tube ordinarily used is a straight blade about 4 inches long, threaded to connect to a piece of quarter-inch brass pipe a few inches long, on the other end of which is screwed the 50 pound gauge by which the velocity of discharge is determined; a union may be used to allow a change in the relative position of Pitot blade and gauge dial.

The gauge best suited for the purpose is graduated in half pounds, from 0 to 50 pounds, which may easily be read to the nearest quarter pound. Gauges of such a small maximum reading should be calibrated by means of a weight tester or reliable test gauge before being used, as they are more sensitive to rough handling than gauges designed for higher pressures. Gauges without pin at zero are recommended.

Method of Making Test

In making flow tests, it is preferable to use 2½-inch hose outlets rather than 4 or 4½ inch steamer connections, for the reason that in the latter the orifice is often not completely filled or the velocity of discharge is not uniform throughout the entire area. Neither of these disadvantages is so marked in the smaller outlets and may usually be ignored entirely. The area of no flow is almost always a segment of varying height in the bottom of the outlet; this height may be estimated by the observer by using the Pitot blade or a rule. In most cases the "hole" or area of no flow is fairly well defined and its proportion to the area of the entire outlet may be calculated. Where the pressure is insufficient to fill the outlet to the top, measurement of the depth of water flowing is sufficient to determine the discharge.

Velocity heads of from 2 to 20 pounds are desirable, as they are read with greater accuracy. For very low velocities an error in the gauge reading has a greater relative effect, and for high velocities there is likely to be much fluctuation. The observer will soon train himself to estimate an average velocity by moving the Pitot tube across the stream; ordinarily for 2½ inch outlets the center reading will be substantially the average. Close to the sides of the outlet there is a retardation of flow, to take account of which a coefficient of discharge is applied to the theoretical quantity corresponding to the indicated velocity. This coefficient has been determined for three makes of hydrants, with outlets of different sizes and with various velocities of discharge; the discharges as measured by Pitot tube at the outlet were compared with those determined by Venturi meter, pitometer and current meter. In these experiments the coefficient of discharge varied from 0.85 to 0.96 with an average of 0.91; a coefficient of 0.90 was employed in computing the tables used by the National Board.

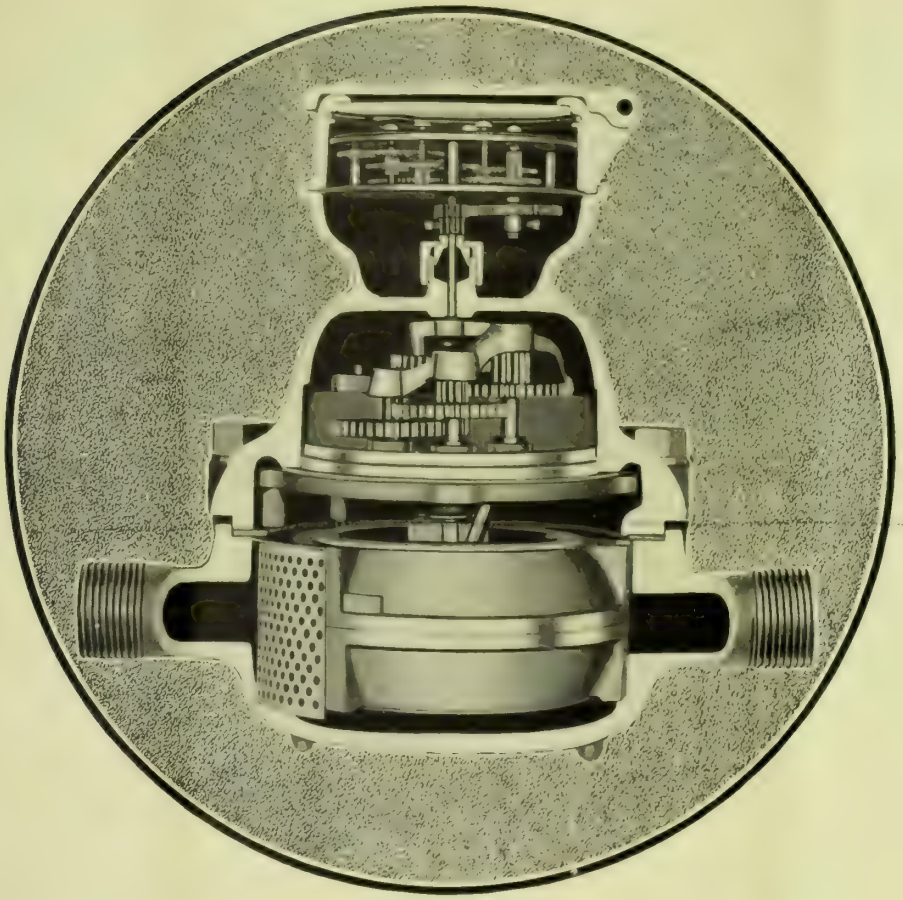
The pressure in the mains before and during the test, is noted by a gauge attached to a hydrant which is preferably in the center of the group of hydrants opened. Knowing the loss of head due to ordinary consumption demands and the additional loss due to a measured flow from hydrants, the quantity available for any other given loss may be closely approximated.

Extensiveness of Test

The number of hydrants opened in an individual test depends largely upon the strength of the distribution system; in a well gridironed system, four are ordinarily used. The object is to draw enough water to lower the pressure in the mains by 10 to 20 pounds, which is sufficient to insure accuracy in estimates of flow available at low residual pressures. Rarely does the number need to exceed four, except in distribution systems of exceptional strength. The layout of the test, of course, varies according to the character of the system; particular attention should be paid to the location of the residual gauge in order that it may represent a true average pressure in the mains when the hydrants are open. One hydrant opened each way from the residual gauge is considered ideal.

Effort should be made to simulate actual fire conditions as much as possible; the ordinary fire department pumper is usually of 750 or 1000 gallons a minute capacity and this is considered a reasonable flow per hydrant; with two hose outlets open, this quantity gives a gauge reading within the most accurate range.

(Continued on Page 32)



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STORAGE & DISTRIBUTION

Opinion of California Health Official Regarding Use of Cross-Connections

State Has Rules and Regulations Covering Such Practice Which Are Often Disregarded by Waterworks Operators

By E. A. REINKE
Assistant Engineer—Bureau Sanitary Engineering.

THE rules and regulations of the State Board of Health governing dual water supplies and cross-connections require that there shall be no physical connection between a private supply or system and a public water system without a permit therefor granted by the State Board of Health. Copies of the regulations, which were adopted in November, 1919, and amended May 12, 1924, have been furnished to all waterworks and health officers in California.

In considering these regulations the State Board of Health held that the water department or company should exercise the same precautions in protecting its distribution system from contamination as it uses in protecting its sources. This should be done with even greater care because no safeguards such as filtration or chlorination are provided after the water has once entered the distribution system. Private individuals have no more right to cross-connect their private supplies with the public supply than they have to tap a power line, telephone line, sewer system or the public water supply mains, and it is up to the water works men to see that no such connections be made and that those which exist be severed. They should take the necessary steps, legal or otherwise, to accomplish these results.

The rules and regulations read in part as follows:

"(2) There shall be no physical connection between such a private source of supply or system and a public water system without a permit therefor, granted by the State Board of Health.

"Dual water supplies and sources with which cross connections exist, or are desired in any form for a public water supply system, shall be held as subject to all the provisions of the Sanitary Water Systems Act. All persons, firms, corporations, public utilities, municipalities, or other public body or institution supplying water for domestic consumption, shall make separate application for permit, under the provisions of the Sanitary Water Systems Act, to supply water from each and every such dual source of water supply or sources with which there exists or it is desired to make any cross-connection."

Permits

We interpret this to mean that permits are to be applied for only when the purveyor desires to use the private supply for auxiliary purposes. In other cases no permit is necessary but one may be applied for.

"Failure to obtain permit so to do, or aiding or abetting in the making or use of said dual supplies or any cross-connection to a public system without obtaining said permit, shall be adjudged as a violation of the provisions of the Sanitary Water Systems Act and subject to all of the penalties provided in said act.

"(3) Water companies or municipalities now or in future furnishing water for domestic purposes, regardless of whether an unrevoked domestic water supply permit from the State Board of Health is held, shall be held responsible to its consumers for pollution of the public system by violation of section (2) and shall forbid service to premises maintaining cross-connections which may pollute the public system, or shall prevent the pollution of the public system by other means acceptable to the State Board of Health. Violations shall constitute sufficient grounds for revoking any domestic water supply permit.

"(5) City officials and health officers shall be urged to investigate from time to time, by inspections and laboratory control, the condition of safety of private sources of supply."

A paper presented at the 8th Annual Convention, California Section A. W. W. A., San Jose, Calif.

Making Flow Tests from Fire Hydrants with Pitot Tube

(Continued on Page 30)

Larger flows may produce erroneous local friction losses.

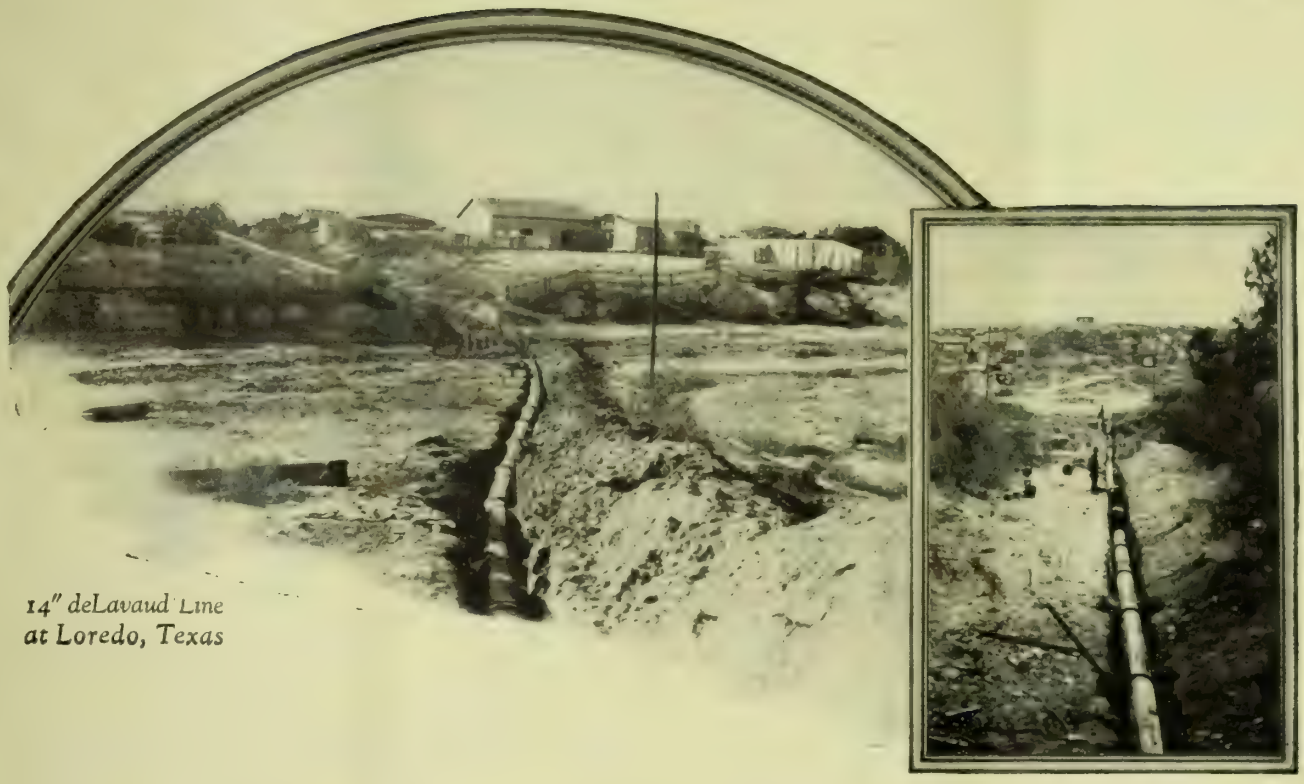
For making flow tests, the California type hydrant in common use on the Pacific coast is the hardest to handle; having the valve directly at the outlet, it is necessary to open the hydrant wide to produce as smooth a stream as possible. With high initial pressures, discharge readings too high for accurate measurement are obtained in this manner and there is in addition the danger of wetting down adjoining property from the spraying produced as the hydrant is first opened. The latter drawback can be reduced somewhat by using short pipes on the outlets, made by leading a 12 or 15 inch length of 2½ inch pipe to an ordinary hose coupling. In extreme cases it may be necessary to shut the gate-valve in the hydrant branch, open the hydrant outlets wide and then control the flow by means of the gate valve. For all other standard makes of hydrants, the opening of the hydrant can be controlled to give the desired flow.

Taking Readings

Hydrants in the group are opened simultaneously and, as soon as the rate of flow is steady, as shown by the residual pressure gauge, a reading taken on each discharging outlet. Operators should be cautioned to shut down slowly as the flow of the group is greater than that drawn in the flushing of a single hydrant, with consequent greater water ram, unless these precautions are observed. Care should also be taken to keep the hydrants open long enough to allow the residual gauge to settle down to a steady reading, the initial drop in pressure as the hydrants are first opened will always be greater than when the surging has settled down and the flow has become steady.

With a definite drop in pressure thus obtained for a known quantity of water flowing, the quantity available at any residual pressure is readily estimated by using the Hazen-Williams hydraulic slide rule. This method will answer for most tests but cannot be used where the assumed residual pressure would lower the hydraulic gradient below any high point of the main between the source of supply and the test. Approximate results may be obtained with an ordinary slide rule.

In analysing results of tests, actual conditions prevailing at the time of a serious fire should be taken into consideration. For instance, an elevated tank of small capacity near the test will result



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in an unduly high rate of flow which cannot be maintained when the tank has been emptied. In cases of this kind the test is best run with the tank shut off.

Tests should be made at representative points in the distribution system. Some should be made on the main arteries, to determine their adequacy, and others on minor distributors to study local losses. Aside from their use as a direct measure of the water available for fire protection, the tests may be of value to the water works engineer in other respects. They indicate the presence of obstructions in the mains, such as closed valves and show the reduced carrying capacities of mains due to tuberculation or incrustation. As they show the effects of a known draft, they furnish data to calculate the effect of any demand and can profitably be employed in designing reinforcements to the distribution system.

Program of Future Reclamation Work Given to Congress

Department of Interior Expresses Opinion Existing Projects Should Be Completed

The Department of the Interior through the Bureau of Reclamation has announced the submission to Congress of a tentative 10-year construction program for future Federal reclamation work in the belief that existing projects should be completed before undertaking new ones. This program, the necessity for which is emphasized, contemplates an annual expenditure of approximately $1,000,000 in excess of the average construction income for the past five years, it is stated.

The announcement, in full text, follows:

The need for a construction program in Federal reclamation is apparent to all familiar with existing conditions. Several of the older projects are unfinished, millions of dollars invested in dams and headworks are bringing no return and will not until distribution works are built. Costly projects recently undertaken should be pushed to completion so that waiting settlers may have water to cultivate their farms. It will require all the income of the Reclamation Bureau for the next ten years to complete existing projects.

COMPLETE EXISTING PROJECTS

Meantime extreme pressure is being exercised to have the department approve new and additional projects. If this should be done the effect would be to secure small appropriations for so large a number of projects as to add greatly to the overhead in construction, delay the completion of projects and postpone delivery to settlers of water needed in irrigation. It is the department's belief that existing projects should be completed before new ones are undertaken.

The department has prepared a tentative program for doing this. It is submitted to Congress for its consideration in the hope that it will at least show the need for such a program. The yearly expenditure contemplated in this program is about $1,000,000 in excess of the average construction income for the past five years and is all that can safely be anticipated for the next 10 years.

Present Practice of Use of Cross Connections

(*Continued from page 28*)

sult of polluted water entering the public water system through cross connections. In California there has been a laxity in active interest—perhaps due to the fact that no serious trouble has resulted. The time is coming, however, when we will be forced to face the issue. Shall we wait as others have until there is loss of life? In the writer's opinion it is high time that some organized body take an active interest and start action. We need public health laws; laws that are effective and enforceable at law and educational campaigns to teach the people the real dangers they are exposed to.

In conclusion the writer feels that it is quite appropriate and in order at this time to propose that a resolution be adopted at this meeting to the effect that the State Department of Public Health and Railroad Commission of California be requested to promulgate such rules and regulations as may be necessary to eliminate the ever increasing danger resulting from cross connections in this state.

Smaller Baker Unit Accepted

Land owners along the lower Powder river have accepted the proposal of Secretary of the Interior Work for a smaller Baker project to include from 6100 to 7400 acres. Acceptance was conditional upon the elimination of a proposed additional cost of $35 per acre for drainage canals which the landowners held would not be necessary. If this item is eliminated they are willing to contract with the government to relieve the reclamation service of any damage from seepage or water-logged lands. It is proposed to build a storage dam at Thief Valley, which would impound about 15,000 acre feet of water and would provide ample supply for the smaller project.

Protecting a Watershed in the Vicinity of a Large City

(*Continued from page 24*)

thoroughly familiar with the country around the mountain, and can exactly describe the location of any fire that may be within the boundaries of the Water District. From his station he can overlook the whole watershed area, and as the station is equipped with a telephone, he is our most valuable man at the time when a fire breaks out. By his watchfulness and quick action in reporting a fire, we are frequently able to reach the scene in time to stop the flames before they do much damage.

The pasture land on our watershed, which is only a very small part of the whole area, is leased for grazing purposes and thereby affords additional protection from fire by keeping the grass short and also by giving us the service of another man, if needed, in the person of the herder.

We hope to keep Mount Tamalpais watershed open to the public as a park, and have gone to the expense of providing fire-places, picnic tables, convenience stations and water taps at certain favorable spots on the mountain side that are best suited to such uses. We ask only that the parties who take advantage of the facilities we offer them for a pleasant outing, shall keep the grounds clean, and respect our rights by doing nothing that will contaminate or pollute our water or our watershed lands.

Conclusion

In conclusion, let me say that we know that we are having success with our methods, at least up to this present time, because we take samples of the water, both before and after chlorination, and these samples are tested very carefully in our own laboratory to be sure that the water is safe for domestic use. Samples are also sent to the State Board of Health at certain intervals for verification. We have always found that even the raw water, before being chlorinated, was quite safe for drinking purposes.

Project Check Sets New Mark

A check for $108,951.41, in payment of one year's construction charges of the Salt River irrigation project, was received by the Bureau of Reclamation from the Salt River Valley Water Users' Association on December 1. This check, it is said, is for the largest amount ever received on yearly construction payments in the history of the Bureau of Reclamation.

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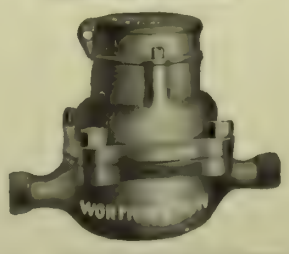

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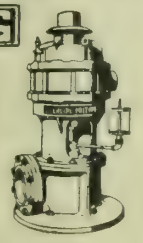

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By William A. Liddell
Instructor of Civil and Sanitary Engineering Massachusetts Institute of Technology

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High Duty Centrifugal Pump Units for City Waterworks

De Laval Makes Many Noteworthy Installations in Eastern Section of Country

Probably the most notable development the past year has been in the building of large, high duty, geared turbine driven centrifugal pumping units. To illustrate the advance which has been made in the duties of this type of pumping engine, the following table is presented, showing the duties developed by geared turbine driven centrifugal pumps of 60,000,000 gals., daily capacity, installed by the City of Chicago, 2 in 1922, 2 in 1924, and 2 in 1926, as follows:

TESTED	1922	1924	1926
Steam pressure—specifications (lb.)	175	175	175
Steam pressure—on test	168.04	142.1	176.15
Superheat—specifications	150°	150°	150°
Superheat—on test	126.6°	123.6°	133.4°
Capacity MGD—specifications	60	60	60
Capacity MGD—on test	60.0	59.0	60.66
Head—specifications	150	150	150
Head—on test	151.51	150.35	152.66
RPM.—specifications	530	530	530
RPM.—on test	507	501.5	507.4
Duty guarantee—specifications	152	168	179.8
Duty actually obtained on official test	154.362	172.0	191.3

Modern high steam pressures, high superheats, better vacua, larger units, and more efficient heat balance arrangements, as secured in part by using exhaust steam from auxiliaries and bled steam from the main units for heating boiler feed water, have made possible still further improvements as shown by the fact that duties of 203,500,000 foot pounds per thousand pounds of steam have been guaranteed for four 75,000,000 gallons daily capacity geared turbine driven centrifugal pumps now being installed in the William Hale Thompson Pumping Station of Chicago.

Altogether, the City of Chicago has in its four pumping stations, 10 geared turbine driven centrifugal pumps, and four electric driven pumps, or an aggregate capacity of over half a billion gallons daily, and constituting more than 50% of the total pumping capacity of the entire waterworks system.

The history of the waterworks system of the City of St. Louis, Missouri supplies another example of the gradual replacement of other types of pumping equipment by geared turbine driven centrifugal pumps. In 1912, the city replaced two 20,000,000 gallon per day direct acting pumps by two 40,000,000 gallon per day centrifugal pumps at the Chain of Rocks Pumping Station. This installation was subsequently augmented by a 110,000,000 gallon per day steam turbine driven centrifugal pump, which was one of the first in which the feed water was heated regeneratively by means of steam bled from an intermediate stage of the turbine.

Recently, after months of exhaustive investigation, careful analysis of bids offered, and visits of inspection to important installations, the St. Louis Water Department has awarded to the De Laval Steam Turbine Company the contract for five turbine driven centrifugal pumps for the Howard Bend Pumping Station, which will be entirely new from the ground up and will contain two high head units of a maximum capacity of 60,000,000 gallons per day each against 360 foot head, two low head units of a maximum capacity of 60,000,000 gallons per day each against 38 foot head and one low head unit of a maximum capacity of 120,000,000 gallons per day against 38 foot head. The high head units will be the most powerful turbine driven centrifugal pumps as yet contracted for in this country.

Supervision of Sanitation of a City Water Supply

(*Continued from page 29*)

The watershed area is divided into seven districts on a basis of work to be performed rather than the area. A patrolman is assigned to each district and lives within the district with complete charge of all sanitary and fire patrol work. Living accommodations and transportation facilities are provided for each district man. Each patrolman is deputized by the sheriff of the county in which his district lies.

Throughout the entire history and program of watershed protection under the jurisdiction of the company especial effort and stress have been directed to the improvement of sanitary and fire hazard conditions by educational and cooperative endeavor. The patrolmen have been trained and instructed to cooperate and work with the watershed population to the end that sanitation and fire protection may be improved. A friendly spirit of willing cooperation has obtained in practically all instances and the accomplishments speak well for the effort put forth.

The entire sanitary and fire patrol is under the supervision of Mr. Paul I. Daniels and Mr. William H. Jordan who is a district forest ranger for Alameda and Contra Costa Counties and in direct charge of the fire control work.

LOS ANGELES, CALIF.—The City of Los Angeles, California, has applied for a license covering a constructed transmission line about five miles long, extending from the city's Big Pine Creek plant to its Intake-Gorge transmission line. The line is located on public lands in Inyo County, California.

For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

Problems of Financing and Land Settlement Discussed by Oregon Congress

Abstracts from Annual Address by Retiring President, Wilford Allen, of the Oregon Reclamation Congress

CENTRAL Oregon was first in claiming attention of the reclamation forces, and agricultural and commercial progress of the district has been closely interwoven with engineering plans for the building of impounding and diverting dams and of ditches and power plants. And while we know that this Congress comes with temper for three days of earnest discussion and deliberation over the problems which must be solved before Oregon can feel that she is on an even keel so far as reclamation matters are concerned, let me say that not the least pleasure we have in coming is anticipation of the promises extended a year ago at Hood River by our good friend, Mrs. Powell, that all your flocks would be drawn upon to dam and ditch and dike the tremendous appetite which our delegates have for fried chicken.

Outline of Program

Two years ago your president outlined his thought of a program for reclamation in Oregon. This program was founded upon three planks: first, settlement of existing projects; second, refinancing of existing projects that were now or that might later become in need of refinancing, and third, new projects. Today, I am more than ever impressed that these vital issues are quoted in the order of their importance, and that they are claiming the best thought and attention of Oregon.

The two year period has been marked by a wonderful amount of thought directed toward the solution of the state's reclamation problems. Land settlement, as a first aid and a complete cure in the instance of some projects, has progressed in a fairly satisfactory manner. Through the work of the land settlement committee of the Portland Chamber of Commerce, of the state chamber, and of other agencies, many new settlers have been brought to the state.

Upon one Oregon project more than one new family for every day of the year was located during the year 1926. But settlement can only proceed, and the settlers be retained upon the lands, when the projects have been placed upon a sound and economical financial basis. Fully settled, some of these projects would have no financial problem, but when we know that it requires 20 years or more to build, settle and bring into full production an average irrigation project, we realize that we must make haste in meeting this financial situation, the refinancing of many of our existing projects.

Legislation Procured

The work of committees from this Congress has been crystallizing into definite thought and this thought into law. For two years now this study has been going forward, how well can be judged by the fact that 18 new laws were enacted by the last legislative session having to do in some manner, mostly remedial, with existing reclamation legislation. These laws do not cure the situation, but they are a long step toward the cure. Two measures which appeared upon the legislative calendar as House bills 114 and 115 were the direct outgrowth of study carried forward by direction of this Congress. At the 1925 session of the Congress resolution authorized a canvass of the situation and report to the 1926 session. At Hood River in 1926 it was further directed that this study be continued and that certain recommendations be embodied in drafts of proposed laws for presentation to the approaching legislative assembly. Every recommendation made at Hood River will now be found upon the statute books, and a discussion of these laws appears upon this program at a later time.

Conflicting Interests

One of these enactments called for the organization of the State Reclamation Commission, giving it certain duties looking toward the rehabilitation of ailing projects. The commission, through the office of the state engineer, is now engaged in most effective work under these measures, and has already made much progress in bringing the conflicting interests in a number of projects together upon a refinancing program.

I have used the term "conflicting interests" advisedly, but I think that in dealing with this question there can be no conflict of interest. There are three parties involved here, the land owner, the bond holder and the state. In the final analysis, however, it all points back to the man upon the land. Unless he can succeed, and be put in a position where he will be enabled to till the soil with profit and from it get a comfortable

(*Continued on page 43*)

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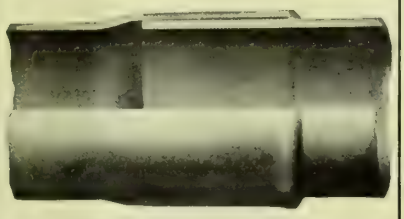

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WATER PURIFICATION

Treatment of Domestic Water Will Solve Sanitary Problems

Resident State Sanitary Engineer Gives Views to Waterworks Men at Recent A.W.W.A. Convention

By RAY F. GOUDEY
Sanitary Engineer—State Board of Health.

A GREAT many water works men, or water works operators come from other states. Some of them think that California is a Utopia, that we don't have to do anything with our waters. I met one gentleman who had just come from Oregon to take care of a water supply; he was having considerable trouble with his chlorinator, and we made things worse. He said, "Where I come from they don't have any trouble with the water at all," and then he corrected himself, "except to keep it out of the milk."

The state has only general laws on watershed protection, such as the committee announces, and which have been mentioned. There are no specific regulations, because we take the viewpoint that each case is a problem by itself, and we must understand the local conditions, and adopt, and make suggestions, point out weaknesses and make recommendations which will give, if possible, the maximum use of the reservoir for recreation, consistent with that which will give a safe water to consumers at all times.

We do our best to elevate the standards, but when it comes to a finality we revert back to minimum refinements, which is more than you water works men would stand for.

Watershed use for recreation purposes is undergoing an evaluation, and we take the standpoint it is all experimental; that we or the water companies should enter upon it with great caution.

Peculiarly, those cities which have let down the bars the least are those which do not have proper treatment. We, therefore, take the stand that any city or water department that wants to let down the bars should first put its water above reproach, and have proper and adequate treatment. By this method of treatment, chlorination is not sufficient in most cases. In the winter time we must remove mud; in the summer time odorous features, and even fish tests of the water must be made.

Complete Treatment Needed

Complete treatment is needed with reference to the water supplies. It is true we have been giving greater care and supervision to the making of the water safe for drinking purposes by taking out the germs.

With the people educated to the point where we would be encouraged, to justify water companies and make the water suitable and potable, we would have a very satisfactory situation. Complete treatment, therefore, means aeration, coagulation, filtration and sometimes syphoning and chlorination in addition.

Filters even when they are designed sufficient and at safe rates only remove from 50 to 75 per cent of the impurities, sedimentation removing 80 to 90 per cent.

The total efficiency, using all of these methods is from 92 to 99 per cent, and it is only by that method you can produce a water above reproach.

Cost of Treatment

The cost of producing such a water is almost negligible, one cent to five cents per thousand gallons, yet it is the duty of every one of us to have proper systems involving the service of water, and we must take it to heart. There is a responsibility, and we must live up to it.

Most of the water companies have been guilty, in the past, with getting-by, I say it advisedly, as cheaply as they can, but I think the times are changed. With complete treatment you can then think of letting down the bars, but only when you have such complete treatment can you do so. This can be helped by regulating your sanitary conditions on the watersheds.

We have in this State, three or four, complete treatment plants (I want to be fair) similar to the East Bay Water Company's two plants. One of these is at Calexico. There are fifteen other plants which I know of that cannot be considered complete; some are simply strainers, some are heavily overloaded, some have not rate trials, and the conditions are not favorable to the producing of a safe water.

There is a very definite sense of progress. A number of communities, such as Los Angeles, San Francisco, Auburn, and I think a few others, have adopted a method of coagulation. It must be remembered that St. Louis adopted this as a preliminary step over 25 years ago; so in that respect we should say we are 25 or 30 years behind the times.

It is only a step, an entering wedge, to when it will have complete treatment, and it is then, and then only, that the complaints we now have of a lack of potable water will vanish into thin air.

A discussion given at the 8th annual convention California Section A. W. W. A., San Jose, Calif.

Preventing the Pollution of Reservoir Water Supplies

(*Continued from page 27*)

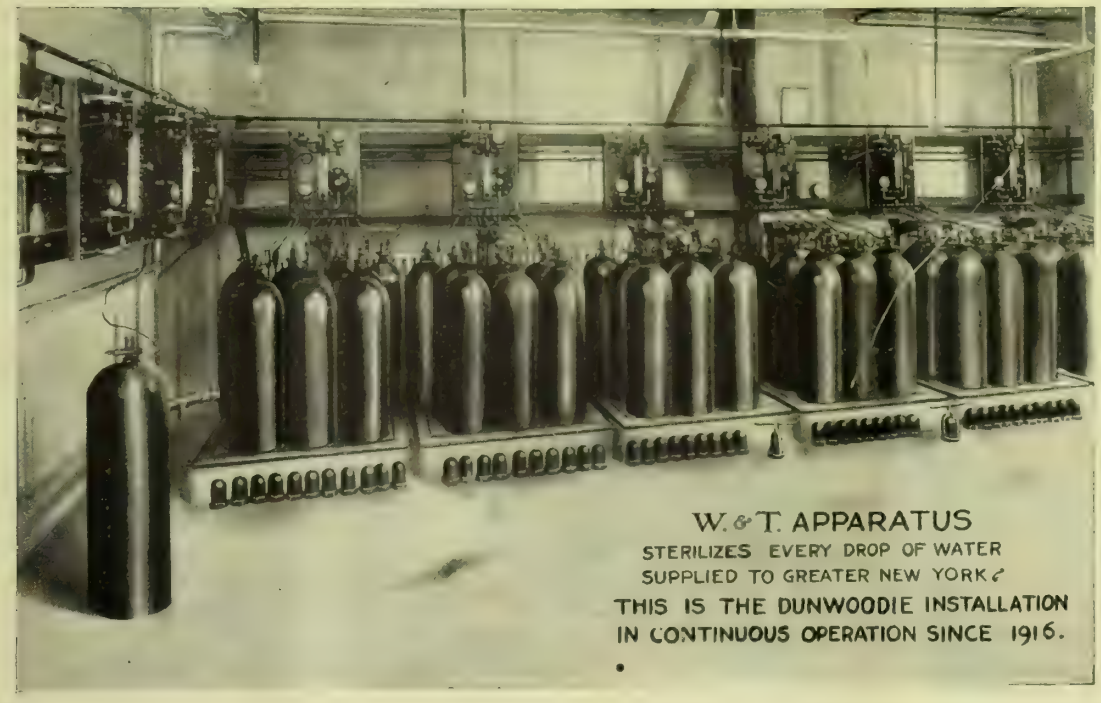
Water Department and must bear our approval, attested by signature of our engineer on the tracings. This enables the Water Department to prevent unsafe installations instead of having to find them after trouble has developed. Leaching cesspools and earth vaults are not permitted on distribution reservoir sheds. Domestic animals, including chickens, are not allowed within 100 feet of the water.

Chlorination

All water leaving distribution reservoirs to enter service should be chlorinated. The equipment should be in duplicate and generally should be automatic in operation. Great care must be taken to obtain continuous and efficient chlorination, and the relatively small cost necessary to secure it should be regarded one of the wisest uses of money. Where the raw water is never heavily polluted, as is the case in Los Angeles, and the reservoirs and conduits are carefully safeguarded, no other purification seems necessary to insure a safe water at all times.

Richard H. Jamison, hydraulic engineer of the Division of Water Rights, State Department of Public Works, has been gathering data for the survey of the water resources of Ventura County, stations in the streams of the valley.

Chlorination Must Be Dependable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Breed Heads Irrigation Equipment Association for 1928

W. I. E. A. Elects Officers at San Jose Meeting Implement Building Planned for Use of State Fair Exhibitors

The regular quarterly meeting of the Western Irrigation Equipment Association was held in San Jose, California, in November, at which time officers for the ensuing year were elected as follows:

President, E. M. Breed, sales manager, Pelton Water Wheel Company, San Francisco; Vice President, J. E. Harley, sales manager, Westco-Chippewa Pump Sales Company, San Francisco; Secretary, E. F. Sewell, secretary, Martin Iron Works, Los Angeles; Treasurer, C. F. Zimansky, manager, G. W. Price Pump & Engine Company, San Francisco; Executive Committee, R. R. Van Ness, A. M. (Jack) Frost, C. B. Noyes, V. E. Nittinger, W. T. Glover, J .E. Lundy, Joseph H. Cox.

E. M. Breed, chairman of the State Fair Grounds building committee, made a report upon progress to date. There is a bill now pending for the appropriation of 100,000 for the erection of a Machinery Hall, and plans have been drawn for an addition to be known as the Implement Building. This will be a one-story structure built around an open court. This court will contain a concrete tank 16 feet wide by 160 feet long, with a large size sump tank. This is to be used by the pump exhibitors. There will be twenty spaces, each 12 by 15 feet, wired for electricity to handle 75 to 100 horsepower loads at each booth. The plans for the building and court are now being inspected by various members of the W. I. E. A.

A number of interesting addresses were made before the association at the evening banquet held at the St. Claire. Joe Brooks, secretary of the Prune and Apricot Growers Association, spoke on the fruit-growing possibilities of California and gave some very pertinent statistics as to the acreage in bearing for various fruits in 1914, in 1927, and as anticipated for 1930. Mr. Brooks thinks that relief for the agricultural situation lies in diversified farming.

Harry Rodgers gave a talk on financing the farmer, and Wm. A. Baylor, secretary of the San Jose Merchants Association, spoke on Credit and Collections. Mr. Baylor stated that in order to forecast the future the equipment manufacturer would best examine his past sales records.

The next meeting of the association will be held in Los Angeles, January 28, 1928.

For Detailed Listings, Branch Offices, Etc., See the Buyers' Guide to Leading Supply Sources—Pages 59-60

"Among the blessings conferred upon the city by the bounty of the gods is the water of Marcia: the clearest of all the waters in the world and distinguished for coolness and salubrity."
— *Pliny.*

Pure Water

In these days of widely diffused scientific knowledge, practically every enlightened community however remote is interested in a supply of pure water. The four main sources of water,—rivers, lakes, wells and springs, are never free from suspended or dissolved foreign matter. Water may be entirely free from disease producing bacteria, yet be so highly colored or turbid as to render it unfit for drinking purposes, or useless to certain types of industry.

A water may be satisfactory today, but what assurance is there that tomorrow the same supply will not become dangerously contaminated? "Protected" water-sheds, since the advent of the automobile with its loads of picnickers, cannot be adequately patrolled. Industry will not settle in a community where the public water supply is muddy, colored or filled with foreign debris.

Water purification as developed by modern sanitary science will remove all suspended matter, color, taste, odor and hardness. It will provide water that is inviting, pleasing in appearance and safe for drinking and domestic use.

This is one of a series of "advertorials" cooperatively designed to broadcast a more general knowledge of the relation between public water supply and community health.

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Treatment of Well Water Containing Sulphur

(Continued from Page 17)

content of some ten parts per million, and it seemed quite an expense for chlorine, so we chlorinated the effluent which ran about two or two and a half parts per million and thereby used less chlorine.

Main Transmission Line

The lower section of the city is served by the 16-inch transmission line from the aeration plant into the city or to the water tower in the city. This tower rides on the line. The line is about 7,000 feet long and was put in about three years ago, I believe. Upon starting the chlorination the consumption was 500 pounds for 5,000,000 gallons per day of 24 hours, and it was a week before we got a free chlorine test more than a few blocks from the plant, and two months before we could get chlorinated up at the tower. We broke in on the inside of the 16-inch pipe line and found there a coating consisting of beggiatoa and other organic matter. This coating was so heavy it seemed to have taken the chlorine up as fast as we could put it in.

During the past winter several wells were shut down, and we chlorinated as heavily as the people would stand for, which left a good deal of free chlorine present. A good deal of construction work was being done at the time and the great amount of water used for this flushed out the system so that the heavily treated water was eliminated except in the outlying districts where there were only one or two houses in a block and hence very little water used.

Filtration

For more than a year we have been considering filtration, our theory being that if we remove the free sulphur and beggiatoa and any bacteria which would form hydrogen sulphide before they reached the mains, we could deliver good water. The City Council, however, had been suffering so long from bad water that they wanted to be shown, so we built an experimental filtration plant to prove our theory.

We built this plant last winter to take care of 70,000 gallons of water per 24 hours. It consisted of three basins, each holding four hours retention, and they were so arranged that they could be used in series or parallel as we wished. There were also two coagulating tanks, a couple of 48-inch gravity filters, a wash water pump and air blower, and two chemical feed machines, one for lime and the other for alum.

We first ran the water through an aerator of three Sacramento nozzles and let it flow on a platform and into a basin. Just after aeration we added the lime, passed that through two more basins, added alum, then to the mixing tanks and on to the filters. After passing the filters the water flowed to a clear well. In this clear well, 7 or 8 feet deep, you could see through the water a dime on the bottom.

There was no taste of hydrogen sulphide, and in the three months the plant ran the effluent only once exceeded one part per million—most of the time it was one-half part or less per million.

Lime Treatment

We used air wash with the lime treatment because the lime tended to gather on the sand grains and this and the free sulphur in the water seemed to be difficult to remove with water wash alone. These hung close to sand and would not be carried free of the wash trough. The air wash broke this crust up nicely and cut down the use of the water and gave longer runs on the filter, averaging 48 or 50 hours, where before we used the air wash we got only 8 or 10 hour runs.

We are building a new plant now which will take care of 5,000,000 gallons a day and will combine both filtration and softening of the supply, and we feel certain there will be no hydrogen sulphide trouble.

Samples from the experimental plant were taken and subjected to various tests, such as leaving them in a pipe to see if they would become bad. After a month's standing they showed as good a test as water just taken from the plant.

The removal of the hydrogen sulphide from the air in Beverly is another phase we are working on. After considering it, the simplest method seemed to be to put in a high stack on the new plant, an ornamental tower, 125 feet high, with a burner in it. With the present plant we had three stacks, 30 feet high, and fans blowing about 12,000 cubic feet of air out of the plant. However, the hydrogen sulphide was dropping down from the stacks five or ten feet away, and killed two or three eucalyptus trees. The trade winds blew it in a direct path away from the plant, and a mile away it caused complaint. We tried burning sulphur in the plant, on the theory that the sulphur dioxide formed would react and produce free sulphur and water, but it didn't work. We tried gas, and we put in a ¾-inch pipe in each stack, turned on the gas and lit it, and let it go. That cut it down some.

We then added another 30 feet to the stacks, making them 60 feet above ground, and for the past year we have not been troubled with odors, except

very occasionally a slight odor close to the plant. It could not be detected at all except when atmospheric conditions were just right for it. There has been no complaint recently as to any odor produced by the plant. Before adding to the height of the stacks the odor was very strong. On one occasion, in fact, an official from Los Angeles came in and asked me "What stability are you getting?" I didn't understand him, and said so. He then asked me if it was a sewage disposal plant we had there. Since burning the gas and increasing the stack height we have had no questions of that kind.

Oregon Irrigation Congress Discusses Future Plans

(*Continued from page 37*)

living, the necessities of life and some of the luxuries, the bond holder and the state as parties at interest must also fail. So the rebuilding of confidence is a first step. This must proceed through the agency of the Reclamation Commission, and all parties to the cause, and every citizen of the state, should aid in bringing about this spirit of confidence and cooperation so necessary in carrying the work forward.

Costs of Development

There are few projects in Oregon that cannot meet the capital costs of their development through a refunding of the debt upon a long-time amortization plan with a possible adjustment of the interest charge such as is made possible under the legislation we now have. When an analysis is made of each project and a readjustment made upon this economic survey, upon the ability of the land to pay and with a limited liability, there will come a new area in Oregon agricultural development.

Try Direct Pumping Plan

Under a concession from the Mexican government, the Colorado River Land Development Company is conducting an interesting experiment to determine the feasibility of irrigating parts of its higher ground by pumping water direct from the Colorado River instead of by gravity flow from the canals of the Imperial irrigation district. The work is being done near Pescadero dam, some distance below the International Line.

The plan, if successful, will make possible the irrigation of lands which, because they are above the level of the canals, cannot now be reached by gravity flow. It will also serve to fill up with river silt present rough spots in the adjacent terrain and will thereby add something to the company's tillable and irrigable lands.

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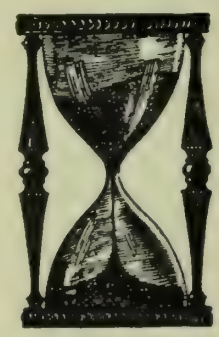

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Agricultural Growth of California Attributed to Irrigation

(*Continued from page 16*)

is based upon investigation made by the State Engineer. The Division of Engineering and Irrigation is charged with the approval of plans for dams other than those constructed by a municipality or public utility and with the construction of river control works and rectification of channels, of which the Sacramento River carries the highest valued tonnage of any river in the United States. It makes hydrographic surveys and cooperates with the Reclamation Board in passing upon plans of reclamation and drainage districts, with the United States Geological Survey in gaging streams and making topographic maps, and with the United States Department of Agriculture in needed investigations.

Work is Diversified

The functions of the division are widely diversified in character, some administrative, some specialized, others executive, but all constructive and contributing to the advancement and well-being of the state. The principal statutory functions may be summarized as follows:

1. To investigate and report on feasibility of proposed irrigation districts.

2. To investigate and report on proposed bond issues by irrigation districts before the California Bond Certification Commission for approval, of which the State Engineer is a member.

3. To supervise expenditures of funds from approved bond issues and to inspect generally the construction work of irrigation districts.

4. To collect data, make surveys and perfect plans for flood control of the Sacramento and San Joaquin rivers in conjunction with work of State Reclamation Board, to review plans for reclamation, and to advise and assist the board. The operation and maintenance of the flood control project for which the legislature appropriated $150,000 in 1927 has been assigned to the Division of Engineering and Irrigation by the Director of Public Works.

5. To maintain and operate all weirs on the Sacramento River.

6. To investigate feasibility of water storage districts, the fixing of their boundaries and passing upon their organization.

7. To investigate the feasibility and organization of water conservation districts. The State Engineer is chairman of the irrigation board.

8. To pass on plans and specifications of dams, and to supervise the construc-

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tion of dams, by other than municipalities or public utilities.

9. To designate the width of draw, and the length of span for bridges across navigable streams.

10. To plan and construct works for rectification of river channels and protection of property from flood damage on the rivers of the state.

11. To direct cooperative stream gaging, topographic surveying and irrigation investigations in cooperation with the federal government.

Along with these many permanent statutory duties which continue through succeeding years, the State Engineer is enjoined by legislative enactments to make special engineering investigations, and serve on special state commissions and boards. An idea of the nature of these special investigations and the amount of work which they involve may be had by reference to the following investigations:

1. The Water Resources of California, which is the most comprehensive of its kind ever undertaken by any state, covering as it does a complete inventory of the waters of the state and providing for a comprehensive coordinated plan for their development.

2. The survey of the Santa Ana River watershed and basin, made in cooperation with Orange, Riverside and San Bernardino counties for the control of floods and for putting to beneficial use the waters of this area.

3. The investigation of the Salt Water Barrier and Iron Canyon Survey, made in cooperation with the United States Reclamation Service.

Grants Pass Relief Planned

The Grants Pass Irrigation District, Oregon, has received temporary relief from its financial trouble, due to heavy floods last spring, through remission of interest and bond payments for 1928, with the taxes collected at the rate of $9 per acre to be used on improvements to the distribution system. The district has an irrigable area of 12,600 acres, and its indebtedness is $154 per acre. Because of the losses suffered early in 1927 by the district, it was feared that interest and bond payments in 1928 would be defaulted. To prevent this a committee was appointed on November 19 to work out a definite plan for refinancing. A basis for a refunding plan has been established. When the survey, now being financed by the state, is completed there will be a foundation for the establishment of interest and bond payments, and the plan, when completed, will be submitted to the tax payers for their sanction or rejection.

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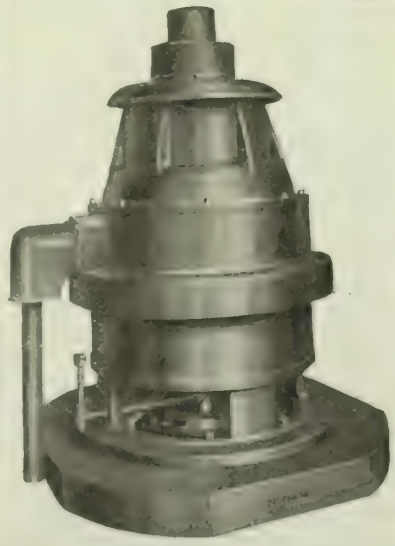

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A Separate Claim Must be Made for Water When Desired for the Purpose of Operating Water Wheels.

Such use although lawful must also be reasonable.

The question of reasonable use of water, similar to the question decided in the California Case of Antioch vs. Williams Irrigation District (188 Cal. 451) is raised in the case of In re Owyhee River Water Rights, 259 Pac. Rep. 292 (Ore.—Sept. 14, 1927.)

One claimant claimed the right to the undiminished flow of the river for the purpose of operating water wheels which were used to lift and divert a small quantity of water for irrigation purposes. This claim was denied by the state engineer and the claimant allowed the amount of water he had appropriated by means of the wheels and applied to the irrigation of his lands. It was not contended that the notice of appropriation embodied notice of an appropriation for power purposes. The claimant claimed that such a use of the water is appurtenant to the claim of water for irrigation. That the entire flow of the river at low water is necessary to the operation of the water wheels.

On these points the Supreme Court of Oregon holds:

> Using a water wheel propelled by the current of a stream for irrigation is lawful in this state. In order, however, for a water user to have a valid appropriation of water for that purpose, we believe his notice of appropriation should have included a claim of the quantity of water desired to be appropriated for power purposes. Even then the appropriation of the current of a stream would necessarily have to be reasonable. (Schodde vs. Twin Falls 161 Fed 43).
>
> It would be unreasonable, in our opinion, to permit a water user whose notice was for a definite quantity of water for irrigation purposes, to hold five or six times the quantity of water so claimed as appurtenant to such claim to operate a wheel for raising the water for irrigation from the stream onto the land of the user.

The Lien of State Taxes Cannot be Wiped Out by Other State Liens

Different lien claims of the state declared co-equal.

The case of Board of Commissioners vs. State, 257 Pac. Rep. 778 (Oklahoma) is of extreme interest to the irrigation districts of the State where the conflict of titles based upon state deeds and district deeds are involved.

The Supreme Court of Oklahoma laid down various rules based upon the statutes of that state, as follows:

> A statute in effect extinguishing the state's lien for taxes on real estate is invalid. Such effect is unconstitutional as being in contravention with . . . the Constitution of Oklahoma, which provides: "The power of taxation shall never be surrendered, suspended or contracted away . . . " a tax lien on real property cannot be made subordinate to or stricken down by statute or judgment to accommodate another lien.
>
> A perpetual tax lien having attached to land is not divested by a sale of the land under judicial process, whether upon execution, decree of court, foreclosure of mortgage, or any other proceeding in view of the . . . Constitution.
>
> The purchaser at the mortgage sale should and is presumed to know that the state has another lien upon the real estate for taxes, and that under the constitution and statute . . . the sale for the mortgage lien is expressly subject to the state's tax lien, and that he (the purchaser) merely steps in the mortgagor's shoes in so far as the state's liens for its trust funds and its taxes are concerned. As indicated, the reverse is true, should the lands be sold for taxes without a foreclosure of the mortgage existing, the purchaser would take the place of the mortgagor and the state would not be barred or precluded from asserting and maintaining an existing claim or right to or a lien upon such real estate in favor of the state by virtue of its trust fund mortgage lien. . . . This conclusion in our judgment has the effect of making the lien claims of the state, in the final analysis, co-equal.

Uncertain Description Makes Deed Void.

Accurate description of land included in district required in irrigation district assessment.

The Bonneville Irrigation District of Davis County, Utah, issued a deed for a delinquent assessment and on a suit brought to quiet title, such deed was declared void on account of the uncertainty of the description.

On the organization of the district, certain lands claimed to be in the district were described as N. E. ¼ Sec. 1 T. 1 N. R. 1 W. 25 acres. The assessor, however, entered upon his records and assessed the 27.5 acres of plaintiff's land situate in Sec. 1 and 6 by the correct description. The tax record and deed were also correct. In holding deed void the Supreme Court of Utah in the case of Bettilyon Home Builders vs. Bonneville Irrigation District. 260 Pac. 269 (Sept. 29, 1927) says:

> "The trial court held that the description of the land as contained in the allotments made by the State Engineer, the County Commissioners, and the directors of the District was so indefinite and uncertain as to form no basis for levying assessments on account thereof, and that the attempted assessment of the plaintiff's lands and the subsequent sale thereof was null and void. . . .
>
> "We think the record fails to show that the plaintiff's land was situated in the district. The action of the Board of County Commissioners in determining that 25 acres of land in N. E. ¼ Sec. 1, belonging to Bettilyon Home Builders, whatever might be deducted therefrom, if such owner had such land in that section, is certainly no determination that 27.5 acres, a small portion of which is in Sec. 1 and the remainder in Sec. 6, and which is beyond the range of the benefits of the district, was to be included in the proposed district . . . . The statute requires the board . . . to determine and plat the lands to be included. . . . This necessarily means that the lands to be included shall be so designated or described that they can be identified.

Plan Extensive Water Survey

A comprehensive survey of the proposed development project for supplementing the water supply of Santa Barbara, California, is to be made. Quinton, Code and Hill, consulting engineers of Los Angeles, have been engaged to make a detailed study of the situation and to prepare plans upon which definite estimates of cost can be based. They have been commissioned to outline a comprehensive plan for the future development of a water supply sufficient for 100,000 people, including an investigation of possible reservoir sites on the ocean side of the mountains and reservoir sites on the Santa Ynez river. Other work to be undertaken by the consulting engineers can be summarized as follows: Preparation of plans to be used as a basis of the cost of a dam on Mono Creek; plans on which estimates can be made for increasing the storage capacity of Gibraltar reservoir if such action should be decided as feasible; estimate of cost of boring a new tunnel through the mountains to supplement the present tunnel; and an analysis of the amount of runoff into the Santa Ynez river and Mono creek.

Developing the Kittitas Division by Bureau Reclamation

(Continued from Page 24)

ed capital of some of the prospective settlers.

The Badger Pocket is a valley whose axis lies at about 45° with the compass. The bench lands on either side have a slope of approximately 5 feet per 100, but near the creek they are very much steeper. Over most of the area,—particularly at the easterly end,—side drainage has cut many channels to Badger Creek, resulting in the typical "washboard" country with the alternating ridges and draws transverse to the axis of the valley. If laterals and roads were constructed on legal subdivision lines they would cross the ridges and draws which, of course, is objectionable. It would be unusual to find a ridge or depression in coincidence with a land line as now laid out.

Method of Division

In subdividing an area without regard to legal subdivision lines the main laterals and roads, for obvious reasons, become the natural division lines between farms; and in an unsettled area it is possible to coordinate the layout of farms and roads to fit a lateral system designed to serve the area most efficiently. In this case there will be three main laterals circling the valley.

There has been no need for building roads in Badger Pocket with the exception of a trail paralleling the Creek. Advantage can therefore be taken of the opportunity to lay out a road system providing direct routes to shipping points which, in this case, are the towns of Kittitas, on the Milwaukee Railroad, and Thrall, on the Northern Pacific.

The road system includes a trunk line down the axis of the Valley, fed by secondary roads following the side depressions from all parts of the district. Roads were projected to give each farm an outlet to the trunk road, following the easiest grades and most direct practicable route to town.

The area has been divided tentatively into 120 farms, ranging in size from 17 to 304 acres; the largest containing 197 acres of pasture lying above the highest lateral. Of the 120 farms, nine have less than 20 acres of irrigable land; twenty have between 20 and 30; and twenty-two between 30 and 40. On the north side of the valley, where the slopes are reasonably uniform, the land is considered adapted to general farming only; consequently farms were made comparatively large, the largest containing 107 irrigable acres. A number of local fruit raisers believe that as the adaptability to fruit raising is demonstrated, farms grad-

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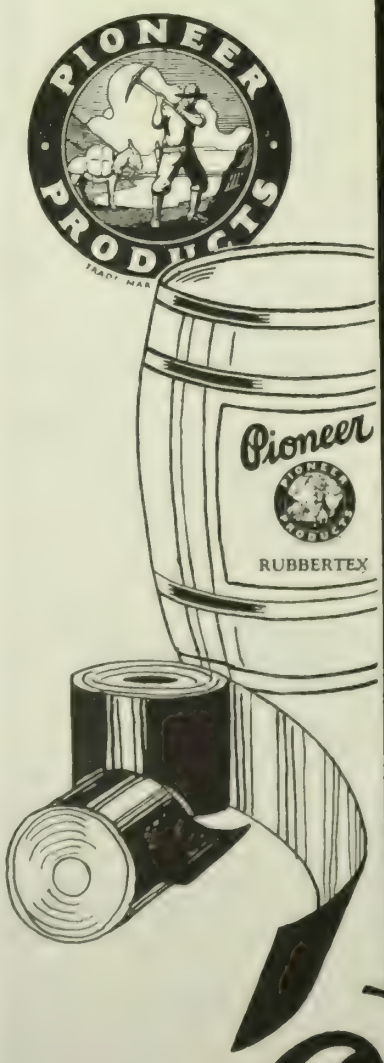

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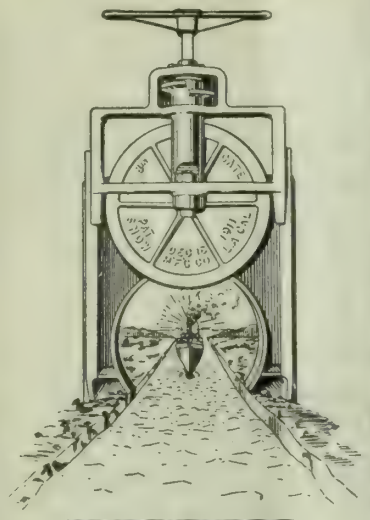

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ually will be subdivided into sizes best suited for that purpose. The distribution system, therefore, has been so planned that little additional expense will be required to provide water for smaller subdivisions. As the more rugged slopes on the south side of the Pocket probably will be devoted to fruit culture from the beginning, the farms in that region were made smaller.

Exchange of Lands

Where boundaries between farms were not fixed by laterals, or roads, they were projected on ridges and in depressions in an effort to avoid the necessity of cutting through farms with laterals, which often results in leaving inaccessible patches of land.

As a result of disregarding legal subdivision lines, a large number of proposed farms include lands held at present by two or more owners. Therefore, in order to carry out the plan, it will be necessary for owners to exchange lands. The complications attending the exchange of lands among so many owners will be annoying but, we hope, not serious.

One complication results from the inclusion within the area of a section of School land granted to the State of Washington by the United States. Section 11 of the Act of Congress, relative to the admission of Washington as a State (Act of Feb. 22, 1889, 25 Stat., 676) provides in part: "That all lands herein granted for educational purposes shall be disposed of only at public sale and at a price not less than ten dollars per acre." Article 16, Section I of the Washington State Constitution states: "Nor shall any lands which the State holds by grant from the United States * * * * be disposed of except in the manner and for at least the price prescribed in the grant thereof, without the consent of the United States."

In order to make exchanges of the State land possible it becomes necessary First:—To secure legislation from Congress permitting the State to dispose of its land in a manner other than by public auction and, Second:—To secure State Legislation providing for such disposal.

During the 1926-27 session of the State Legislature a Bill was passed providing for the subdivision and disposal of State lands on Federal reclamation projects. The Act authorizes the subdivision of State lands to conform to the division of farm units provided in the general plan; authorizes the sale of State lands in farm units as laid out; and provides for the exchange of State lands in Federal reclamation projects for public lands of the United States in the same project, or elsewhere in the State of Washington, of approximately equal appraised value, in the event such exchange is authorized by an Act of Congress.

If the desired Federal legislation can be secured the problem will be simplified. If found desirable, the States' Section 16 within the area selected for trial of the land settlement plan, could then be exchanged for public land either in the Kittitas project or elsewhere within the State; but it may be desirable to retain the State land within the Badger Pocket area as it will afford an opportunity to demonstrate the practicability of State cooperation.

There are no problems connected with the subdivision of railroad lands for the reason that officials of the company are in sympathy with the plan and have offered to cooperate to the extent of exchanging lands.

The practicability of the plan rests largely with the individual land owners. Refusal of one owner to exchange land with his neighbor would cause the plan to be less attractive. So far four meetings of representative land owners have been held to discuss the plan and ways of overcoming the difficulties. Maps showing the proposed subdivision have been made available to Badger Pocket land owners and recently a group of representative business men and farmers went over some typical tracts which had been laid out according to the general plan and "flagged" in order that the practicability of the plan could be studied in the field. To date, the reaction has been favorable, and the situation looks promising for carrying out the plan in its entirety.

Form of Trusteeship

Several methods of handling the exchange of lands have been discussed. The consensus of opinion seems to be that unguided transactions between individual owners would be doomed to failure. It has been suggested that all interested parties pool their lands with a trustee, who would be entrusted with their exchange and sale upon the basis of appraised values. Even though this plan might be acceptable to the United States, State, and Railroads, it apparently does not appeal to the individual owners as they insist on making their own deals. In the plan which at present appears to be the most practicable, the trustee would serve only as a medium through whom transactions between individuals would be consummated after they had agreed, in general, upon the terms. In transactions involving Public, State or Railroad lands, the sale would be contingent upon the purchaser acquiring the portion of the farm lying on the other side of the legal subdivision line and final action would be withheld until the purchaser actually had acquired it.

Record of Hydraulic Resources for Industrial Development

(*Continued from page 20*)

secured. Every year's delay in securing them means additional expense to the State. Let us make the start as soon as possible. Particularly is this course justified now in view of the state policy of marking time on actual new irrigation development so far as state aid is concerned, as indicated by the suspension of the half-mill levy for another biennium. We should not be discouraged by our failure to secure the desired appropriation at the last session of the legislature but rather should we be stimulated to greater effort at the next season.

Need I add anything to what I have already said to emphasize the need for this class of data in connection with irrigation work? I hardly think so. I am sure that everyone within the sound of my voice knows and appreciates this need. We have yet remaining in this State about 3,000,000 acres of land to be reclaimed by irrigation and, regardless of how long the reclamation of these lands may be deferred, these data should be building up now as a sure and safe basis for the developments. It may be added too, that the longer we defer the securement of these data the longer will actual development itself be delayed.

To refer again to our committee report, and I commend it to your careful perusal, you will note there listed a number of large and definite losses that irrigation projects have suffered as a result of insufficient stream flow data. I shall not discuss these in detail but, suffice it to say, that the history of irrigation is amply marked with financial wrecks that have come about, in large measure, through taking chances on the indications of short-time, stream flow records. The losses from these causes to irrigation projects in this State, including private, federal, district and state-aid projects is doubtless well in excess of $2,000,000 and this state is not unique in such a record.

Outline of a talk presented at annual meeting of Washington Irrigation Institute, Wenatchee, Washington, November 17, 1927.

H. M. Gilbert, fruit grower and shipper, of Yakima, was elected president of the Washington Irrigation Institute at the annual convention held recently in Wenatchee. Other officers elected for the ensuing year are: Roy R. Gill, Spokane, first vice president; Fred Graham, Seattle, second vice president; and John Peterson, Omak, and E. N. Benson, Seattle, directors for a three-year term.

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Proper Water Utilization in the Nazas River Valley

(*Continued from page 13*)

when picking of cotton is very pressing and brings unusual increases in wages. When floods are large in volume defense levees may be broken, inundating cotton fields ready for picking, as in 1919 when over 70,000 acres of cotton were flooded with a loss of over 40,000 bales, and in 1925 when about 30,000 acres were flooded with a loss of over 16,000 bales. When floods come early, or are very large, or no land is available, the loss of water is very great and flows to the Mayran lagoon. Greater amounts of water are used to flood for cultivation, as planting is done several months later the following year. Experience has shown that production increased greatly on flooded lands planted to cotton in February and March when they had one or more rainfalls in May and June. The great discrepancy in area planted between lean and abundant years makes the agricultural risk very great.

The above shows very obviously the necessity and urgency of bringing some relief, if economically feasible, to agriculture. The only solution is the construction of one or more impounding dams to hold the water and release it when needed, at times holding over the excess from abundant years for dry ones. This will stablize regional agriculture, wages, commerce, work and industry.

A New Storage Dam

As time passes the solution of this problem becomes more and more urgent. Technical work was started a long time ago and some field work was accomplished from 1898 to 1901 by the engineers of the Nazas River Board at intervals on the Fernandez Canyon, just 19 miles above the head of the valley, and found that with a dam about 150 feet high it would be possible to impound 961,000 acre-feet. A geological study of the site and some borings were made then. Later, in 1909, Pearson & Son, Ltd., contracted with the federal government to study the site mentioned and to design a structure. Borings in several places showed that no firm rock could be obtained even below 150 feet of river bed. This decided them to look for other sites, three of which were found much further above. The Palmito site, just below where the Ramos and Oro rivers meet to form the Nazas, was considered the most desirable.

At this point the gorge is narrow, 30 feet from river bed to firm dioritic rock, and with a structure 226 feet high the water impounded amounts to 1,469,000 acre-feet. The watershed above this point has an area of 7,430 square miles, almost 55 per cent of the total Nazas watershed and 80 per cent of the runoff. It has been estimated that one third of the capacity will be diminished in 283 years if all silt and sediments are retained, but as the system of irrigation cannot and should not be changed at present, large gates at the bottom of the dam are needed to release uniform artificial floods when most desired. The distance from the Palmito site to the head of the valley is about 131 miles. The cost of the structure, according to Pearson & Son's report in 1911, was $5,700,000.

Power could possibly be developed and all would at once be consumed at any of the cities of Durango, at Torreon, or at the mines in the vicinity of the dam. But the real benefit obtained from the dam would be: flood control, much better beneficial use of the water utilized at present, and beneficial use of all the waters now lost. Work and wages would also become more uniform.

There is no danger of the water table rising to less than 12 feet from the surface, as soil is very pervious and conse-

NAZAS RIVER
YEARLY AND MEAN ANNUAL RUNOFF
IN THE LAGUNA DISTRICT

Year	Acre-Feet
1891	28,901
1892	859,242
1893	186,368
1894	1,857,595
1895	543,525
1896	928,315
1897	2,059,223
1898	810,095
1899	203,858
1900	688,782
1901	269,780
1902	588,955
1903	607,943
1904	646,477
1905	1,869,146
1906	1,797,032
1907	404,877
1908	504,799
1909	975,664
1910	243,954
1911	587,945
1912	817,738
1913	1,485,955
1914	1,397,218
1915	714,315
1916	1,122,231
1917	1,165,277
1918	543,963
1919	2,663,557
1920	1,133,812
1921	185,634
1922	222,846
1923	2,072,552
1924	623,905
1925	1,420,933
1926	2,265,032
1927* to Nov. 1	1,165,781

Average—969.025 acre-feet for 37 years.

*River flow just about 1,200 cubic feet per second and diminishing rapidly. Only upper canals taking water. No more water expected for rest of year. One acre-foot equals 1234 cubic meters.

quently percolation is very heavy. Also, as pumping is developed the danger gets further away.

Conclusions

The water users, by forming a company or an irrigation district, could easily undertake the work, and that would be the best way, as the federal government is willing to guarantee the bonds that necessarily would be issued for the purpose; or the federal government may declare, through the National Irrigation Board and in accordance with the New Irrigation Law of 1926, that this work is of public benefit and execute it with the additional object of colonization. It might also be done by a private company having a concession to impound only the "excess waters" (these are no less than 40 per cent of total runoff) with the privilege of charging a fixed amount for their use in the Laguna District, and later, as water users would find the benefit accrued to the use of the water at will, they would surely pay for the privilege of having their water impounded by the company.

Scappoose Dikes Completed

The exterior dikes of the Scappoose drainage district, Oregon, were completed late in November, according to a recent report from W. L. Powers, secretary of the Oregon Reclamation Congress. Nine and one half miles of dikes, beginning at the Multnomah county line and extending down along the Columbia slough bank in a crescent shape, with its center at Scappoose, outline the bottom land area of this district. The average height of the dike is 10 feet. The pumping plant, located near the Santosh slough in the northern part of the district, consists of two centrifugal pumps of 18,000 gallons per minute each and driven by two 50-horsepower motors. Over 15 miles of interior channels are being installed to connect sloughs and ponds with the pumping plant, which is to take care of interior drainage and seepage. An electric power line has been built across the district to supply power to the pumping station and will be made available for use of farmers. A detailed soil survey of Columbia county is being made and the area included in this drainage district has been mapped in detail so that soil information will soon be available to settlers on the area.

Governor Frank C. Emerson, of Wyoming, made a recent trip to Washington, D. C., where he was called as one of the special advisers to Secretary of the Interior Hubert Work on Colorado River matters.

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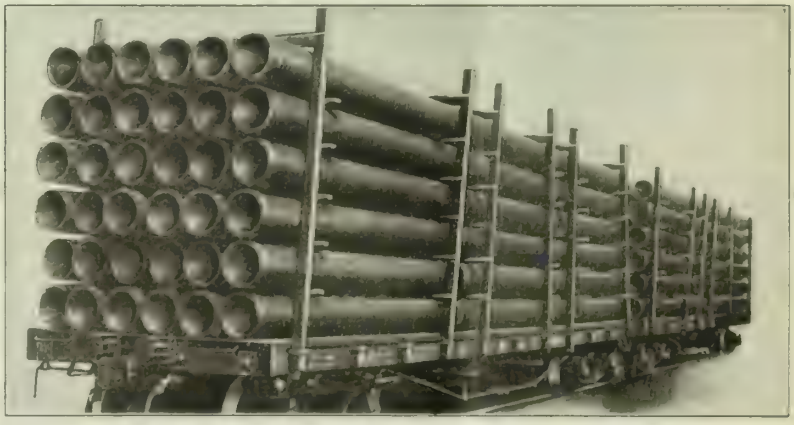

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SURVEY *of* HYDRAULIC DEVELOPMENT

A summary outline of developments contemplated on Western projects which have been announced during the month

Irrigation Development

ELLENSBURG, WASH.—The Bureau of Reclamation will soon advertise for bids for the construction of the North Branch Canal, eleven miles of new work located between Swauk and Jones Creek.

SALT LAKE CITY, UTAH.—Work has been ordered upon the second lake unit in the Utah lake section. It is estimated that 10,000 acres will be included in this new district, and will be supplied with water by canals as the first unit has been in the past.

SEATTLE, WASH.—The Hell Roaring Irrigation Company is about to ask for bids for the construction of the main canal of the district. This project is located near Glendale, Klickitat County. Present plans call for 108,000 cu. yds. excavation, and 575,000 b. m. feet of 3 x 10 lumber for flume construction.

CHULA VISTA, CALIF.—Plans have been completed for improvements in the Tijuana River Irrigation district, San Ysidro, which include the drilling of five 12 inch wells, installation of two or three pumping plants, one 750,000 gallon reservoir, and twelve miles of pipe lines and ditches. A bond issue of $150,000 is planned.

TOPPENISH, WASH.—Another important step in the development of the reservation irrigation project has been made by the letting of a contract for the first unit of the pumping plant. This plant is to contain turbine operated centrifugal pumps capable of handling 1,000 second feet. There are to be three of these pumping plants, two more to be constructed in the near future.

SAN BERNARDINO, CALIF.—Thomas E. Hunt of Los Angeles, has been granted a permit to develop 5 second feet and 20,000 acre feet in Rattle Snake Canyon and Arrastre Creek, for the irrigation of lands in the Apple Valley district. Estimated cost, $250,000. The project is located about 10 miles north of Lake Arrowhead at a point midway between Victorville and the Box S ranch.

CALIPATRIA, CALIF.—Completion of the Niland Water District, for which bonds were voted in December, 1925, was assured recently when the directors voted to sign a new contract for acquiring the new district when completed. The bonds have been prepared and a reputable bond house has contracted for their purchase after their validation. In the new district there will be approximately 200 miles of canals and ditches, with concrete syphons, etc. It is expected that work will start about January 15, 1928.

NEW YORK CITY—A contract amounting to $20,000,000 has been negotiated between the Abyssinian Government and the J. G. White Corporation for the construction of a dam across the Blue Nile in the vicinity of Lake Tsana. Irrigation of tremendous desert tracts is the purpose of the dam. The expected substantial profits for sale of water which will accrue to the Abyssinian Government, will enable the reigning regent to embark soon on a plan calling for the employment of American teachers, physicians, technical men, and skilled artisans, with a view to throwing off the inertia which has held the country back through many centuries.

Reservoirs and Dams

SIGNAL HILL, CALIF.—Election will be held Dec. 14 to vote on a $250,000 bond issue to provide for reservoirs, pumping plant, and the purchase of the present plant from the city of Long Beach.

SAN DIEGO, CALIF.—City Council has under consideration an appropriation of $20,000 for repairs to the spillway at Lake Hodges dam. Louis C. Hill, Hollingsworth Bldg., Los Angeles, consulting engineer.

VANCOUVER, B. C.—Articles of incorporation have been granted to the West Canadian Hydro-Electric Corporation, with a registered capitalization of $1,000,000. This company plans to develop power at Shuswap Falls for the purpose of supplying power to Vernon.

LAKE CITY, COLO.—Mr. R. D. Webb has applied for a preliminary permit to construct a storage reservoir of 30,000 acre feet and a power house of 2,500 Kw. capacity, a short distance below the Lake Fork of the Gunnison River, near Lake City, Hinsdale County, Colorado. The power will be used for mining purposes.

JUNEAU, ALASKA—Jacob Marty, Sr., has applied for a license to construct a power project on Spruce Creek, in the Tongass National Forest, near Juneau, Alaska. It is proposed to construct a timber dam, a conduit, and a power house to be equipped with a 48-inch impulse wheel. The power capacity is estimated at 500 horsepower, which it is intended to use for mining purposes.

IDAHO FALLS, IDAHO—Messrs. J. M. DeCoster, Lawrence Poitevin and Steve Meikle have applied for a preliminary permit to construct small dams, with pipe lines and power houses on Palisade Creek, within Targhee National Forest, near Idaho Falls, Bonneville County, Idaho. The power capacity is not known. When developed, the applicants plan to use the power for public-utility purposes.

SAN LUIS OBISPO, CALIF.—A new water system for the city is awaiting the granting by the federal government of a permit to construct a dam in Lopez Canyon, in the U. S. Forest Reserve. The city has had several surveys made with the idea of providing additional water for the city, and have picked out several sites along Lopez Canyon. Plans call for the ultimate erection of five dams, two as soon as the permit is granted, and the three others when necessity demands.

SAN DIEGO, CALIF.—Edwards, Wildey & Dixon, Los Angeles contractors, have notified the city council that suit will be instituted if settlement for work already completed on the Sutherland Dam is not made. Construction at the new site is underway and is not affected by the proposed suit. The city claims works was not done according to specifications, but the contractors claim to have been working under orders of the city engineer.

THE DALLES, OREG.—Application has been filed for the construction of a storage dam at Lost Lake. The water impounded by this structure will provide the municipal supply for the city from the run-off from Mount Hood. Tentative plans call for a six mile pipe line twenty-four inches in diameter to take water from Cold Springs Creek, thence through a rock tunnel approximately one-quarter mile in length, dumping the water into Deer Creek, a tributary of Mill Creek.

COCHABAMBA, BOLIVIA—The city of Cochabamba has awarded a contract for the installation of a waterworks system costing approximately $100,000, according to American Minister Jesse S. Cottrell, La Paz. A series of wells and reservoirs are to be established north of Cochabamba on the Roco River where the water will be impounded. The contracting firm is to run the main pipes into the city and the branch lines to the various houses, the owner being compelled to make the necessary connections. The name of this successful firm is available under reference Bolivia No. 252558.

SEATTLE, WASH.—At a special session of the city council recently, an ordinance was presented and approved which provides for the construction of a $2,000,000 dam at Hanging Rock above Diablo Canyon on the Skagit River. As soon as plans are available, bids for the construction work will be called for. It is assumed that the structure will be of the Ambursen type, as this has been frequently spoken of in reference to the installation. The city council has approved the expenditure of $8,500,000 already this year, which will be spent in connection with the various power developments of the river.

VANCOUVER, B. C.—Details have recently been received from Consul Harold S. Tewell, Vancouver, relative to various construction projects in British Columbia, Canada. Among these are the following: A new club building costing $125,000, a concrete dam costing $150,000, and a hotel building costing $5,000,000. Plans have been approved also by the Dominion Government for the construction of a tunnel at North Vancouver, approximately ½ mile in length, the walls and roof to be of 18-inch concrete, costing approximately $261,000. Further information is available under reference Canada No. 252771.

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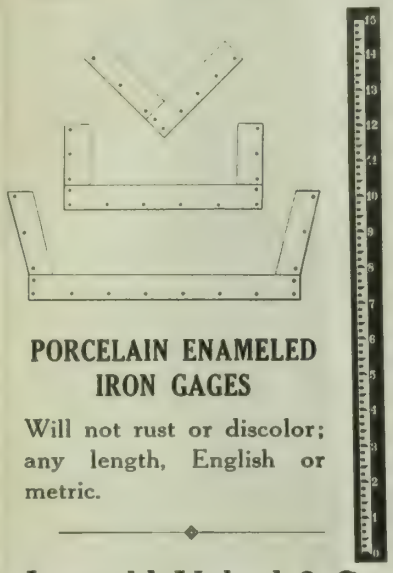

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MONTEVIDEO, URUGUAY—The Uruguayan minister of public works has announced that the so-called Rio Negro project will be put into execution during 1928, according to Consul General C. Carrigan, Montevideo. The plan contemplates the erection of a dam across the Rio Negro at a point in western Uruguay where the stream is broad, and the transmission of power from that point to Montevideo, a distance of about 150 miles, as well as to surrounding towns. An irrigation project is to be included in the plan. A survey of the possibilities has been made by a commission appointed by the ministry on public works. This commission was so favorably impressed as to recommend an expenditure of over 20,000,000 pesos (the Uruguayan peso is now worth $1.01). The ministry of public works intends to invite leading construction companies in various countries to send representatives to Uruguay to study the proposition and advise the Government as to the best location for the plant. Bids will then be invited for the erection of the dam and power plant. The company which is awarded the contract will probably be expected to arrange the financing.

Reclamation and Drainage

MERCED, CALIF.—Merced Irrigation District will start work soon on about $35,000 new construction, involving drainage canal construction, dragline work, etc. Of this amount, $16,000 will be expended before the first of the year.

SAN GABRIEL, CALIF.—The city council has accepted the proposition of Redfield, Van Evera & Co. to take over a block of between $15,000 and $20,000 of the $55,000 storm drain bond issue so that the city can proceed with the construction of the Longden storm drain. City Engineer C. N. Wright has been instructed to prepare plans for the drain.

SANTA ANA, CALIF.—County Flood Control Engineer Paul Bailey has announced that surveys have been completed in both Brea and Carbon Canyons for proposed dams. The Carbon Canyon site is located on Telegraph branch one of the main forks of the canyon. The Brea Canyon work contemplates the construction of two dams. Surveys are also nearing completion in Santiago Canyon.

LOS ANGELES, CALIF.—(San Fernando Valley Plan)— E. Court Eaton, chief engineer, county flood control department, has prepared a preliminary outline for a San Fernando Valley flood control plan. The valley has at present 127 miles of main channel to be protected, covering a territory of 485 sq. miles. Plans for financing the program of construction as proposed by Mr. Eaton are being laid by property owners and civic organizations.

SAO PAULO, BRAZIL—By a recent decree it was decided to proceed with the straightening and canalizing of the Tiete River, following the plans drawn up several years ago by a Brazilian sanitary engineer, according to Consul C. R. Cameron, Sao Paulo. The Tiete River runs through the city of Sao Paulo in an exceedingly crooked channel and is bordered within the city by a flood plain having an area of about 10 square miles. It is proposed to pay the expenses of this work by expropriating the land necessary for the straightening and canalizing operations and later selling this land, considerably enhanced in value meanwhile by the improvements to be carried out. For the initial expenses of the work, the law cited authorizes the contracting of a loan of 10,000,000 milreis (current value of a milreis is about $0.118) in bonds to be issued at par, bearing 8 per cent interest.

Sewage Disposal

SAN LUIS OBISPO, CALIF.—The $25,000 sewer bond issue was sold October 17 to First Securities Co. of Los Angeles at a premium of $1419, par, and accrued interest.

BURBANK, CALIF.—The $325,000 sewer bond issue has been sold to the Bank of Italy and the Anglo-London-Paris Co., at 4¼%, with accrued interest and a premium of $2008.

BEAUMONT, CALIF.—Koebig & Koebig, consulting engineers, Title Insurance Bldg., Los Angeles, are engaged in a survey and preparation of a cost estimate for a sewer system for Beaumont. A report will be made to the city council soon.

HARBIN, CHINA—The Harbin municipal government is planning the construction of a city hall at a cost of approximately $300,000 (Mexican), waterworks and a sewerage system to cost between $7,000,000 and $8,000,000 (Mexican), a municipal theater to cost $200,000 (Mexican), and a number of commercial buildings. The water and sewerage system will be given as concessions.

NORWALK, CALIF.—At a recent meeting of the chamber of commerce, plans were considered for the formation of a sewer district as a part of the county sanitation district program. A. K. Warren, chief engineer of the county sanitation districts, was one of the speakers. He advised the dissolution of the present Norwalk sanitary district and the organization of a district under the county plan.

MONTREAL, CANADA—News of construction projects in Canada received recently from Trade Commissioner Walter J. Donnelly, include the following: Bids have been received for enlarging the capacity of the filtration plant of the city of Montreal to double its present capacity, the award is to be announced shortly; tenders are to be called for the laying of a trunk sewer line, costing about $250,000, and plans are being completed for a grain elevator costing about $2,000,000, at Vancouver. Details relative to these and many other construction projects in Canada are available to accredited American firms under reference Canada No. 7.

HONOLULU, T. H. — The Honolulu Water Commission is preparing plans for an interceptor sewer with 20,000 feet of concrete tile-lined tunneling. Dredging of Pearl Harbor is under way and a new dredger is being built for the work.

Local capital to the amount of $750,000 has been subscribed for building a mill on the island of Panay, 50 miles north of Iloilo in the Philippine Islands, to be outfitted with machinery made in Honolulu shops.

Real estate is inactive but prices are firm. Surveys are being made for a large relaty promotion project in the vicnity of Waikiki, to fill in swamps and create a mile-long sand beach.

SAN BERNARDINO, CALIF.—The $650,000 outfall sewer and disposal plant bond issue carried Nov. 30, 1503 to 622. Currie Engineering Co. and C E. Johnson, consulting engineer, Anderson Bldg., San Bernardino, are engineers for the project. The proposed pipe lines will consist of 15-in.,

18-in., and 24-in. lines capable of handling conditions for the next 50 years, and the disposal plant will be of the filtration type, involving two broken rock beds each 200 ft. wide and 60 ft. in length. Four treatment tanks 40 ft. in diam. will care for the initial process of the treatment after being carried to the plant from the central collecting station at Mill and E Sts. Pre-chlorination of the sewage flow, final settling of the clarified.

LIMON, COSTA RICA—By a recent law the President of Costa Rica is authorized to issue bonds against the public treasury in the amount of $300,000 and the municipality of Limon is authorized to raise a loan for a similar amount, with the subsidiary guaranty of the State, the total receipts to be used for the construction and renovation of the water and sewerage systems, drainage, and paving in the city of Limon, according to Vice Consul Thomas J. Maleady, Port Limon. A board of five members will be appointed to take charge of this work, three to be named by the executive power and two by the municipality of Limon. The manner of awarding contracts has not yet been determined. It is believed, however, that the construction award will be made to that firm which, in addition to making an attractive bid, offers to take over the entire bond issue.

Waterworks

BLOOMINGTON, CALIF.—Financial interests of Los Angeles are arranging for the purchase of the Mutual Water Company, reorganization and enlargement. The contemplated work is estimated to cost approximately $300,000.

MARTINEZ, CALIF.—Utility and Service, Inc., is the name of the new syndicate which proposes to build a water system to pipe water from Conn Valley, Napa County, to serve the industrial concerns along the Contra Costa bay shore.

SAN BERNARDINO, CALIF.—An election will be held on December 28 for the purpose of voting the formation of a water district in the Del Rosa section. The district proposes to issue $40,000 in bonds for construction work.

TIPTON, CALIF.—A domestic water company has been formed to provide the city with domestic water. The property owners were instrumental in the formation, and the company will be known as the Tipton Mutual Water Company.

CHULA VISTA, CALIF.—Extensive improvements to the Sweetwater Water System are to be made in the near future, according to reports. A contract has been recently let for 3½ miles of cast iron pipe, of various sizes ranging from 18 inch down to 8 inch, which is but a portion of the new pipe that will be purchased during the coming year.

ESCONDIDO, CALIF.—H. Hawgood, consulting engineer, H. W. Hellman Bldg., L. A., has compl. plans for improvements to be made to the Escondido Mutual Water Co.'s system, Escondido, San Diego county. Work proposed includes: 2600 lin. ft. 50-in. riveted steel ¼-in. penstock, 950 and electrical equipment for 350 KW. unit. Estimated cost, $100,000. J. B. Dixon, secretary.

ESCONIDIDO, CALIF.—The Escondido Mutual Water Company plans the issuance of $375,000 in bonds for the purpose of retiring old bonds and performing new construction work. Included in this new construction work is the lining and enlarging the conduit from the San Luis Rey River to Lake Wohlford, to a capacity of 70 second feet, and the completion of the 50 inch penstock below Lake Wohlford and the installation of additional electrical equipment.

CALI, COLOMBIA—A loan of $2,000,000, out of a total of $5,000,000 authorized for the city of Cali, Colombia, has now been floated, according to bankers' statements recently issued. The proceeds of this issue are declared to be for the purpose of retiring all outstanding indebtedness of the municipality (said to amount to less than $675,000), for the enlarging and improving of the city water supply, and for other productive purposes.

BILBAO, SPAIN—A number of public work projects are now under consideration for the city of Bilbao, Spain, including a new railway station for the Caminos de Nierro del Norte, three bridges, the enlargement of various streets and boulevards, a new water supply system, and certain minor modifications of sections in the older part of the city, according to Consul H. A. Doolittle, Bilbao. The names of the public works officials to be addressed in this connection are available to interested firms under reference Spain No. 35x.

Unit Bids

PHOENIX, ARIZ.—Sayler Construction Co., Lamar, Colo., was low bidder Aug. 10 at about $163,258.45 for work under items 1,, 2, 3 and 4, of Roosevelt Irrigation District program of canal construction et cetera. The items are: (1) the construction of a main canal located from 3 to 20 miles northeast, north and northwest of Buckeye, Ariz., and 25 miles in length, involving about 400,000 cu. yds.; (2) construction of 46 structures appurtenant to main canal; (3) construction of distribution laterals, about 38 miles in length, involving 132,000 yds. excav.; (4) construction of 420 structures appurtenant to lateral distribution system.

Charles and Geo. K. Thompson, 701 Brockman Bldg., Los Angeles, were apparently low on item (5) at $198,766.50 for timber trestle, and $225,181 for steel for the construction of a metal flume across the Agua Fria River about 12 miles west of Phoenix, 5960 ft. in length.

Charles and Geo. K. Thompson were also low on item (6) at $186,715.20 for the construction of a collection canal system, west of Phoenix, about 25 miles in length, involving 345,000 cu. yds. of excavation. It was reported that all bids on item (6) were rejected. The bids were referred to the engineers for tabulation. The bids were:

(a) Sayler Construction Co.—(1) $58,800, (2) $38,141.45, (3) $19,875, (4) $46,442; total of items (1) to (4) $163,258.45; (5) no bid, (6) no bid.

(b) Schmidt & Hitchcock—(1) $57,000, (2) $60,270.04, (3) $22,200, (4) $60,510.05; total of items (1) to (4) $199,980.09, (5) no bid, (6) $204,576.74.

COOLIDGE DAM, ARIZ.—Hardie-Tynes Mfg. Co. Birmingham, Ala., was awarded contract by U. S. Indian Service, San Carlos, Ariz., at $14,625 f.o.b. Birmingham, for furnishing 30 pieces 8-ft. cast iron pipe for the Coolidge Dam. This company also bid $19,463 f. o. b. San Carlos. Other bids:

Joshua Hendy Iron Works, San Francisco, f. o. b. Sunnyvale, $17,890.

Vulcan Iron Works, Wilkes-Barre, Pa., f. o. b. Wilkes-Barre,, $14,565.

Llewellyn Iron Works, Los Angeles, f. o. b. Los Angeles, $21,370.

Llewellyn Iron Works, Los Angeles, f. o. b. San Francisco, $25,383.

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Watershed Protection Necessary for Water Conservation

(Continued from page 22)

building or repairing roads, telephone lines, lookout stations, and last but not least building up a contact with neighboring communities to enlist man power when needed.

Recently the Farm Bureau and the U. S. Forest Service conducted a sightseeing tour that had a more significant motive than sightseeing. It contemplated the awakening of a "forestry consciousness" in the participants representing numerous organizations in the county, such as service clubs, chambers of commerce, American Legion, farm centers, fruit associations and others. It was a rare opportunity to get first hand information from the Forestry officials themselves in the surroundings of their own jurisdiction.

Forestry Nursery

The first stop was scheduled at the forestry nursery near the County Park. Seedlings of Arizona ash and Coulter pines were seen in the nursery beds established last spring by the supervisors at the instance of the Farm Bureau. Seed was furnished by the University Extension Forester and the late County Forester, Robert Northcross.

Headed by J. B. Stephenson, ranger, and J. E. Elliott, supervisor of Cleveland Forest, the caravan wended its way on a circuitous route up the Black Star Canyon, over a recently constructed ranger road built jointly by the Federal Forest Service and the County of Orange at a cost of $28,000. On the way we passed the site of the proposed Santiago Dam soon to be constructed by the Carpenter Water Company, and the Irvine Company. The Black Star road is a typical example of a network of similar roads planned by the Forest Service to approach every strategic point in the reservation. An eight mile steady climb brought the group to Oat Flat at the top of the Santa Ana ridge dividing Orange and Riverside Counties. It was the first time that traffic passed over the new Black Star Canyon road.

From Oat Flat the crowd was led afoot to a promontory near Sierra Peak, an elevation of 2800 feet. A very wonderful panorama greeted them. San Gorgonio, the sentinel of the desert, could be seen in the east; majestic San Antonio loomed up on the north; Mt. Wilson, the astronomer's roost, was sighted further west, and the Pacific was apparent in the direction of San Pedro. It was here that Supervisor J. E. Elliott of the Cleveland Forest pointed out the system of firebreaks, the proposed new lookout station on Sierra Peak and the new telephone lines at the time under construction. Corona lies practically at the foot of Sierra Peak, a distance of only eight miles.

Continuing down the grade, the caravan arrived at the Black Star Ranger Camp for lunch, which was served "fire fighter style." The noon respite gave an opportunity for brief informational talks by Woodbridge Metcalf, Paul Bailey, Supervisor Willard Smith and Everett Stanford. Each developed various angles of the conservation program for the state, district and county.

Floods May Come

"Right now" Metcalf commented, "we are reading about the devastating floods of New England. It can happen here just as well, in fact Weather Bureau records show a precipitation of 11 inches in one hour at San Diego in 1887. This is the heaviest recorded rainfall in the United States. It might occur again, and we should be prepared. Southern California is one of the greatest markets for lumber, yet this section is little interested in local forestry activities. Southern California should be concerned about the natural reforestation program, and actively interested in conservation of the watershed areas." Metcalf added that the recreational receipts for use of the national forests have almost equalled the grazing receipts in California. Next year recreation will yield the greater income and will probably continue to do so as time goes on.

Paul Bailey, Orange County flood control engineer, explained the close relation between the forest cover and the heavy silting taking place in the valley floor after floods. The capacity of the narrow river channels is taxed to a greater degree in the absence of suitable brush cover.

Willard Smith, County Supervisor, commended the excellent work of the Forest Service and said that all county funds used for forestry protection was not primarily to benefit the forestry department, but were provided because of very evident local benefits to Orange County.

Continuing on after the sumptuous "feed" and "after dinner talks" our pilgrimage proceeded up the Santiago Creek, passing the lower end of Silverado Canyon, getting its name from the silver mine once operated there. A splendid view of the type of underbrush which makes up much of the covering was had along this route. Different varieties of sage, mesquite, alders, sumac, some live oak and wild holly, made up the bulk of the growth.

The concrete Harding Reservoir, located in Harding Canyon just a short walk from Madame Modjeska's former

home, was the objective of the first stop in the afternoon. W. W. Hoy, engineer for the Santa Ana Valley Irrigation Company, and also designer of the dam, presented data on observations and measurements he made during and following last year's storm period. He explained the very heavy runoff following the Hathaway fire which burned over 8000 acres in the Harding and Santiago Canyons. The fire started October 31, 1926, and continued to November 7. Two to three hundred men fought the fire during the week it raged. It was stopped before it got into the Silverado Canyon. When the heavy rains of November 26, 1926, occurred, there was no runoff in Silverado Canyon, but in Harding Canyon swept by fire, the erosion and silt was so great that it filled the entire dam to the very top. The normal runoff from Harding Canyon, according to Hoy, is 30 acre-feet. Last year, however, the denudation from fire caused a runoff of 130 acre-feet, an increase of over 300 per cent.

Run-off Shows Ash

Samples of water taken at 10 o'clock on the morning of November 27, during the storm, showed a content of 40 per cent ash and silt. The heavy erosion was very apparent in the Santa Ana river below the mouth of the Santiago Creek. A deposit of an inch of black sediment was spread over the flood plain.

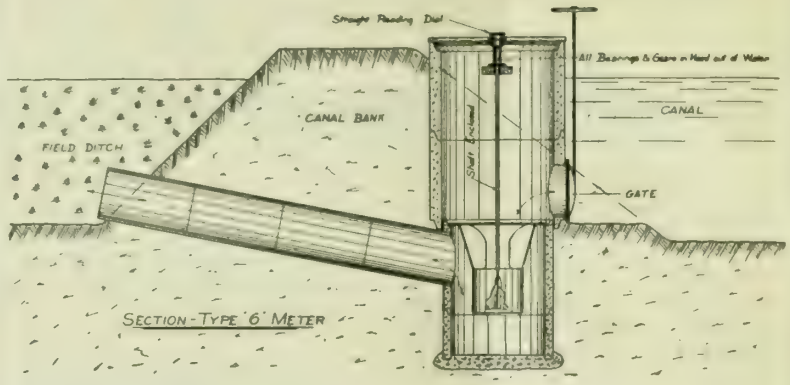
The runoff in Santiago Creek was 60 per cent greater in the 1926-27 season for the same rainfall than for previous storms. Hoy's measurements show that 34,000 acre-feet of water came down the Santiago last season, as compared with 8,800 acre-feet in 1921-22 season. There was a loss of 24,000 acre-feet to the county from this source.

The evidence on every hand during the day and the personal contact with the men who are charged with the responsibility of maintaining our forest areas, gave a new and more vivid appreciation of the conservation problem to the participants on the tour. It opened up a new vista of opportunity for cooperation in an undertaking vital to the permanency of the community, both rural and urban.

Forest Protective League Formed

On November 18 twenty-five representative growers and business men met at the call of the Farm Bureau forestry committee to consider such cooperation with the forestry officials. The enthusiasm was most marked and culminated in the formation of the Orange County Forest Protective League. John Ragan, of Villa Park, was elected chairman pro tem and A. M. Stanley, Santa Ana, secretary pro tem.

The RELIANCE METER



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WHO'S *WHO* AND WHO'S *WHERE*

IN WESTERN PETROLEUM

Personal Notes and Impersonal Observations About Men You Know

W. J. Neely has recently been appointed water master of the Wadsworth water system, Washoe county, Nevada.

L. R. Grannis, district representative of the crane department of the Link-Belt Company, has just returned to Los Angeles from a trip to the home office of the company at Chicago.

Louis C. Hill, of the firm of Quinton, Code & Hill, consulting engineers of Los Angeles, has been chosen as the official nominee for vice president from Zone IV of the American Society of Civil Engineers.

A. F. Hastings, Pacific Coast manager of the Dorr Company, has just returned from a trip to Europe. While on this trip he stopped off for a few days in New York and visited the home offices of the Dorr Company.

A. A. McCallum, Pacific Coast manager of the S. K. F. Industries, who makes his headquarters in San Francisco, was a visitor in Los Angeles during the early part of December. Mr. McCallum has recently returned from a company convention held in the East.

F. W. Slattery, formerly engaged in drainage construction work in the Imperial Valley, and more recently with the Merced irrigation district, has been appointed manager of the W. R. Hearst estate, San Simeon Ranch, above San Luis Obispo.

George Bailey, assistant to the general manager of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pennsylvania, has been appointed district merchandising distributing manager of the Pacific Coast district. Mr. Bailey will have his headquarters in San Francisco.

W. A. Perkins, who for some years has been with the State Division of Water Rights, has been appointed field engineer to take care of the State's interests in all dams that are constructed within the State. Mr. Perkins was recently a visitor in Los Angeles and consulted with E. Court Eaton and S. M. Fisher on the various dams that are being built by the Los Angeles flood control.

JOSEPH H. COX

Vice President of Frank J. Kimball Company, Los Angeles, who, last month, was elected president of the Pacific Hydraulic Engineering Association. Mr. Cox has just retired from the presidency of the Western Irrigation Equipment Association, in the affairs of which organization he has been most active since for several years past. He is a member of the Advisory Board of Hydraulic Engineering.

Timothy G. Turner has recently been appointed western manager for the Copper and Brass Research Association with headquarters in Los Angeles. The association is comprised of the leading manufacturers of copper and brass products and its efforts are directed primarily toward educational work. Mr. Turner is a publicity man and will follow very closely the developments of copper and brass products in the West.

Mark Rose has been named by the members of the board of directors of the Imperial Irrigation District as a representative to go to Washington, D. C., in connection with the Boulder Dam Bill. Mr. Rose is expected to start for Washington about the middle of December.

D. L. Schieber has been appointed sales engineer for the Pittsburgh Equitable Meter Company for the Pacific Coast district and is making his headquarters in Los Angeles. While Mr. Schieber is not entirely a stranger in California, he has for the past twelve years been located in Dallas, Texas, in connection with the water works industry.

W. W. Mutter, Pacific Coast manager of the Northwest Engineering Company, with headquarters in San Francisco, was a visitor in Los Angeles during the early part of December with the Collins-Kay Machinery Company, who are the Los Angeles distributors. Mr. Mutter left about the middle of the month for an extended trip through the East, during which he expected to visit the home office of the Northwest Engineering Company at Chicago.

A. L. Sonderegger, consulting engineer, Los Angeles; R. L. Parshall, irrigation engineer, U. S. Department of Agriculture, in charge of hydraulic laboratories, Fort Collins, Colo.; Franklin Thomas, professor of civil engineering, California Institute of Technology, Pasadena, California; Fred Scobey, irrigation engineer, U. S. Department of Agriculture, Berkeley; Ivan Houk, research engineer, U. S. Bureau of Reclamation, Robert A. Monroe, engineer, Pacific Gas and Electric Company, San Francisco, and J. C. Stevens, consulting engineer, Portland, Oregon, are members of the committee of irrigation engineers of the American Society of Civil Engineers which met recently in Portland for the purpose of checking up on irrigation and hydraulic reports for the next session of the society.